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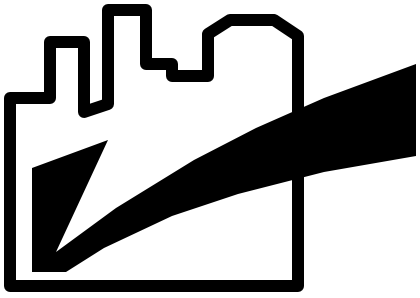

COM*check-EZ*™ Compliance Guides

Commercial and High-Rise Residential Energy Code Compliance
Version 2.1 for 2000 IECC

April 2000

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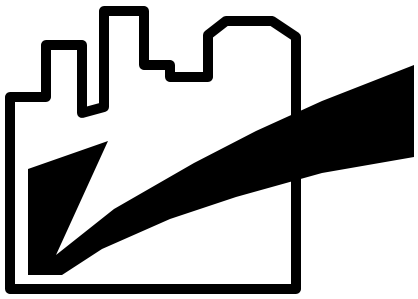

COM*check-EZ*™ Compliance Guides

Commercial and High-Rise Residential
Energy Code Compliance
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Inside Version 2.1

Scope and Application Guide
Envelope Compliance Guide
Mechanical Compliance Guide
Lighting Compliance Guide
Software Compliance Guide
State Maps and Prescriptive Packages
Field Inspection Checklist
Software CD-ROM

Scope and Application

About COM*check-EZ* Materials

COM*check-EZ*™ is an optional way to demonstrate compliance with energy codes for commercial and high-rise residential buildings. It is applicable to most commercial buildings and high-rise residential buildings three stories or more above grade.

Use this version of COM*check-EZ* to demonstrate that your commercial or high-rise residential building design complies with the 2000 Edition of the International Energy Conservation Code (IECC). Other versions are available for the 1998 IECC, codes based on the ASHRAE 90.1 ('89) Code, and several state energy codes.

Residential buildings, townhouses, and garden apartments with three stories or fewer are covered under the residential chapters of the code. MEC*check*, a companion product to COM*check-EZ*, is available to demonstrate compliance for low-rise residential buildings.

The COM*check-EZ* materials simplify and clarify energy code requirements. Although they have a somewhat different format than the IECC itself, the requirements presented in this guide generally match those found in Chapter 8 of the 2000 IECC. However, COM*check-EZ* should be used only if approved by the building authority having jurisdiction.

COM*check-EZ* includes a manual method (prescriptive compliance path) and a software method (system performance compliance path). You can use either method to demonstrate that a proposed building design complies with the energy code requirements.

Only construction referenced in the building permit application must comply with the code requirements. Each system—envelope, mechanical, and lighting—can comply separately. For example, if the building permit application is for only the lighting system, then the envelope and mechanical provisions do not apply.

COM*check-EZ* can be used in conjunction with other compliance methods available under the IECC. For example, Chapter 7 of the IECC references the ASHRAE/IES Energy Code for Commercial and High-Rise Residential Buildings as well as IECC Chapter 8, Design by Acceptable Practice for Commercial Buildings. You can mix requirements but not within major sections (envelope, mechanical, and lighting) unless separate permits are being requested for each system. For example, an applicant can apply for a shell permit using COM*check-EZ* to demonstrate envelope compliance. When requesting a permit for the mechanical system, the applicant can show compliance with IECC Chapter 8 using COM*check-EZ* or show compliance with the ASHRAE/IES code but cannot pick and choose mechanical requirements from either source.

This Scope and Application guide gives building design professionals and code enforcement officials an overview of the COM*check-EZ* materials and explains how the energy code requirements apply to a variety of commercial building situations.

You can access a U.S. Department of Energy Building Standards and Guidelines Program (BSGP) web site at http://www.energycodes.org to learn about COM*check-EZ* and get free downloads of the complete package of materials. If you have questions about the materials, call the BSGP hot line at 1-800-270-CODE.

COM*check-EZ* Materials

The COM*check-EZ* materials include

- Scope and Application Guide
- Envelope Compliance Guide
- Mechanical Compliance Guide
  - Simple HVAC Systems
  - Complex HVAC Systems
  - Service Water Heating Systems
- Lighting Compliance Guide
- Software Compliance Guide
- State Maps and Prescriptive Packages
- Field Inspection Checklist
- Software CD-ROM

The *Envelope, Mechanical,* and *Lighting Compliance Guides* contain energy efficiency requirements. They provide direction in completing each compliance certificate used to demonstrate code compliance. These guides limit you to a prescriptive compliance path with no performance tradeoffs.

When performance tradeoffs and greater design flexibility are desired for one or more systems (envelope, mechanical, or lighting), the COM*check-EZ* software provides a performance path alternative for each system and generates a report used to demonstrate compliance.

For code enforcement officials, EZ tips for plan check and field inspection are included at the end of each compliance guide. The *Field Inspection Checklist* is useful when inspecting buildings for COM*check-EZ* compliance.

Envelope Compliance

The *Envelope Compliance Guide* contains energy efficiency requirements related to the building envelope. General requirements are included for limiting air leakage, certifying components, and installing vapor retarders. Climate-specific insulation and window requirements are provided in the prescriptive packages for each climate zone.

Mechanical Compliance

The *Mechanical Compliance Guide* contains energy efficiency requirements for heating, cooling, ventilating, and water heating. Included are requirements for heating and cooling system controls, outdoor-air ventilation, duct construction, and service water-heating systems. This guide also contains instructions for trading off economizers with higher-efficiency cooling equipment.

Lighting Compliance

The *Lighting Compliance Guide* contains basic energy efficiency requirements for lighting systems. This guide identifies control, switching, and wiring requirements and types of exterior-lighting sources that comply. It also shows you how to demonstrate compliance with building- or area-specific interior-lighting power limits.

Software Compliance

The *Software Compliance Guide* provides instructions on obtaining, installing, and using the COM*check-EZ* software. The software is a highly flexible way to demonstrate compliance with minimal input. The software is designed to run on most Windows-based computers. The envelope portion allows roof, wall, window, floor, and skylight performance tradeoffs within the permit stage. The lighting portion allows you to quickly determine if your lighting design meets the interior-lighting power limits. The mechanical portion displays and prints a checklist of mechanical requirements based on descriptions of the HVAC systems, plants, and water-heating systems used in the building. The software automatically generates a report that can be affixed to project plans and submitted to code enforcement personnel to demonstrate compliance.

State Maps and Prescriptive Packages

The *Envelope* and *Mechanical Compliance Guides* contain requirements that vary with climate. Use the State Maps and Prescriptive Packages to identify the climate zone and corresponding prescriptive package number for your proposed design used in determining climate-specific requirements.

Field Inspection Checklist

The *Field Inspection Checklist* helps ensure required energy efficiency measures are properly installed in the building in accordance with the building plans and specifications.

The checklist helps ensure required energy efficiency measures are properly installed in the building in accordance with the building plans and specifications.

Scope

You can use COM*check-EZ* to demonstrate energy code compliance in the design and construction of most types of commercial and high-rise residential buildings. However, you must use the COM*check-EZ* software method to demonstrate envelope compliance for buildings having a window-wall ratio (WWR) of more than 50%.

Applicable building types include

- offices
- retail, grocery, and wholesale stores
- restaurants
- assembly and conference areas
- industrial work buildings
- commercial or industrial warehouses
- schools and churches
- theaters
- apartment buildings and condominiums with four or more habitable stories
- hotels and motels

Except for electric lighting and service water heating systems, requirements do not apply to

- very low energy use buildings (i.e., peak energy usage less than 3.4 Btu per hour per square foot or 1 watt per square foot of floor area)
- buildings or portions of buildings that are neither heated nor cooled
- buildings designated as historic.

Applications

The following sections explain how COM*check-EZ* applies to a variety of typical building situations. While these examples can help illustrate various code applications, your local building department is the final authority on how the code applies to a project.

Unconditioned Spaces

Unconditioned spaces are exempt from the envelope requirements of the code. To be considered unconditioned, a space must have no heating or cooling system and not be conditioned indirectly by an adjacent space. Generally, if the conductance of heat between a space with no heating or cooling system and adjacent conditioned space is

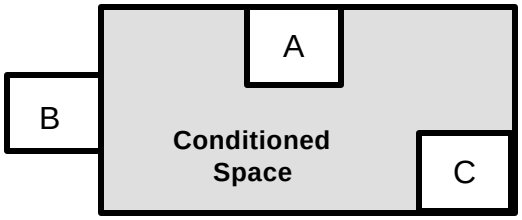
greater than the conductance between it and the outdoors, the space is considered conditioned.

A problem can occur when a building owner erects an unconditioned shell building and fails to comply with energy efficiency requirements. When a future tenant applies for a permit to install heating and cooling equipment, the building envelope must be brought into compliance, possibly requiring significant alterations. The lighting system, if installed in conjunction with the shell building, must also be brought into compliance in a similar situation.

Many code enforcement jurisdictions require that building owners sign an affidavit when applying for the initial building permit for a shell building. The owner acknowledges in the affidavit the potential difficulties associated with postponing envelope or lighting compliance. To minimize these difficulties, permit applicants should demonstrate compliance when each system is installed.

Question

The sketch below shows a one-story building with four different spaces. Spaces A, B, and C do not have installed heating or cooling equipment and are not controlled for human comfort**.** Are any of these spaces considered *unconditioned* and hence not subject to the envelope requirements of the code?



Answer

The conductance of heat is based on the wall area and the amount of insulation in the walls. Space A is in contact with conditioned space on three sides. Space C is in contact with conditioned space on two sides. Space B is in contact with conditioned space on only one side. If we ignore the roof and assume that all of the walls shown have the same amount of insulation, the conductance of the walls between the conditioned space and space A is greater than the conductance of the walls in contact with the outdoors. Space A is considered conditioned space, and all requirements applicable to conditioned space apply. For Space B, the conductance of its wall adjacent to conditioned space is less than the conductance of walls in contact with outdoors, so B is considered unconditioned. For Space C, the conductances are equal, so C is also considered unconditioned.

Newly Conditioned Spaces

When an unconditioned space becomes conditioned, the space is considered an addition. All envelope, lighting, and mechanical systems and components associated with the addition must comply with the energy code requirements as if the addition were a new building.

New Construction in Existing Buildings

Tenant improvements in an existing building (the base building has been constructed, but the individual tenant spaces have not been completed) are considered new construction.

All envelope, lighting, and mechanical systems and components being installed must comply with some or all of the energy code requirements.

Existing systems and components not subject to the current permit application must comply with the energy code requirements only when conditioning previously unconditioned space.

Changes in Occupancy

Generally, if a change in occupancy does not include physical changes to the building and does not result in an increase in energy use, energy code requirements do not apply. If the occupancy change would result in increased demand for energy, compliance with the energy code (or approval by the code authority having jurisdiction) is required. Your code enforcement official may need to evaluate these changes on a case-by-case basis to determine which code requirements apply.

Alterations to Existing Conditioned Spaces

Alterations to existing conditioned spaces must comply with the following criteria:

- New systems in any alteration must comply with the energy code requirements.
- Altered components of existing systems must comply with the energy code requirements; unchanged components do not have to comply.
- If an alteration is made to an existing system and the resulting system does not comply, all altered components must comply, and the altered systems must use no more energy than before the alteration.

Determining how to apply these alteration requirements can be confusing, particularly with existing building envelope and lighting systems where some requirements apply at the system level. Just remember that each altered component (e.g., window or lighting fixture) must comply, and, if the entire building envelope or building lighting system is not being brought into compliance, the alteration cannot result in greater energy use.

Question
A building owner wants to install a new window in an old building, which will increase the glazing area in a building that already does not comply with building envelope requirements in the code. What requirements must be met to demonstrate compliance for this alteration?
Answer
The new window will increase building energy use even though the new window complies with code requirements; e.g., for U-factor. Therefore, the increased glazing area must be offset with other envelope improvements. You can use the COM*check-EZ* software to identify an alteration, such as adding insulation that will offset the added glazing. This is done by showing that the envelope compliance index is no worse with the new glazing and insulation than it was without the alterations.

Question
A building owner wants to rearrange some interior partitions and reposition the light fixtures in the affected rooms. Do any requirements apply to this alteration?
Answer
Because the alteration does not change the connected lighting load, the lighting system will use no more energy than before, so the overall lighting system does not need to comply. Only the control, switching, and wiring requirements apply. In this example, each newly arranged room must have a light switch, and any one- or three-lamp ballast must be tandem-wired.

Additions

Additions are newly constructed conditioned spaces or previously unconditioned spaces after heating or cooling equipment has been installed. All additions that are not exempted under the code must comply with the energy code requirements.

Envelope, lighting, and mechanical systems and components in additions are treated the same as they are for new buildings. Existing systems whose services are simply extended into an addition do not have to meet current code requirements, although the code does apply to new components of the system in the addition.

For additions, you can use two options to demonstrate compliance:

1. Treat the addition as a stand-alone building, ignoring the common walls between the existing building and the addition, and show compliance for only the addition. You can use either the COM*check*-*EZ* manual or software method to demonstrate compliance using this option.
2. Treat the existing building and the addition as a single building. In this case, the addition must not increase annual energy costs for the combined building (existing plus addition) beyond those for the existing building (in its pre-existing condition) with an otherwise identical addition whose components and window-wall ratio do comply with the code. This option provides greater design flexibility as improvements to the existing building can be used to offset noncompliant features in the addition.

   However, we recommend that you consult with the building department before using this option to verify their acceptance of the compliance method. In addition, this option is not supported by the current COM*check*-*EZ* materials.

Buildings with Multiple-Occupancy Types

The energy code addresses buildings with multiple-occupancy types as follows:

- **Minor Occupancy** - If an occupancy type takes up less than 10 percent of a building's conditioned floor area, then the area devoted to that occupancy type must meet the same requirements as the major-occupancy type.
- **Multiple and Single Occupancy** - The same compliance process is used for commercial buildings with multiple-occupancy types as for those with a single-occupancy type. The COM*check*-*EZ* manual and software methods allow you to specify multiple-occupancy types.

- **Mixed Residential and Commercial Occupancy -** This occupancy type occurs when a building has three or fewer stories and contains both residential and commercial occupants, with the minor-occupancy type taking up more than 10 percent of the building's conditioned floor area. The residential and commercial occupancies are considered separately because they fall under two different scopes. Thus, two compliance submittals must be prepared using the appropriate calculations and forms from the respective codes for each type. Mixed residential and commercial buildings having more than three stories must comply as commercial buildings, regardless of the number of stories that are classified as residential occupancy.

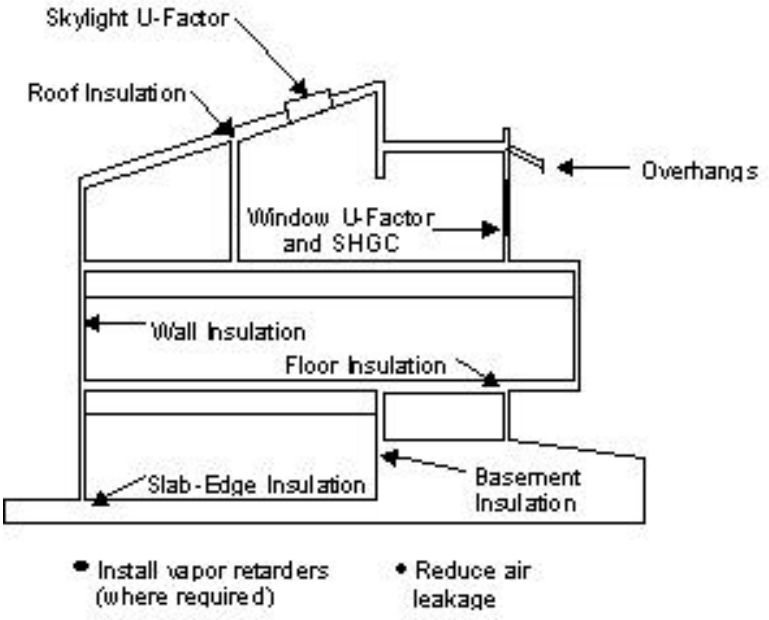
Envelope Compliance

Envelope Requirements

You can use COM*check-EZ*™ to demonstrate that your commercial or high-rise residential building design complies with the 2000 Edition of the IECC. This revised COM*check-EZ* guide is not restricted to use with buildings three stories or less in height, as was the previous version.

This guide covers the energy code requirements for building envelope and provides a simple prescriptive method (manual method) for demonstrating compliance. Most envelope requirements vary with climate. This guide contains requirements for all climate locations within the United States, as well as instructions on how to demonstrate compliance with these requirements.

The COM*check-EZ* software is an alternative compliance method offering greater design flexibility by allowing tradeoffs between envelope components, including roofs, walls, windows, floors, and skylights. You can demonstrate compliance with minimal inputs and generate a compliance report to submit with your building permit application. Refer to the *COMcheck-EZ Software Compliance Guide* for instructions on obtaining and using the software.



What the Energy Code Covers

To promote energy efficiency in building envelopes of commercial and high-rise residential buildings, the energy code requires that

- air leakage be limited through the building envelope. This guide contains requirements for limiting air leakage.
- insulation R-values and glazing and door U-factors be certified. This guide contains requirements for certified building components.
- vapor retarders be installed in nonvented framed ceiling, wall, and floor areas in many climates. This guide contains requirements for vapor retarders.
- insulation levels for walls, roofs, and below-grade walls and glazing areas, and U-factors for windows and skylights meet or exceed minimum efficiency levels – these minimums are listed in prescriptive package tables for specific climate locations. This guide contains instructions on how to determine if your design complies with these levels.

Demonstrating Compliance

The COM*check-EZ* manual method (prescriptive compliance path) requires minimal calculations and is the simplest way to comply. It is a package approach that requires all components in your design to meet or exceed prescribed efficiency levels contained in the prescriptive package table for your building's climate zone. If one component does not meet the prescribed efficiency level, you must use the COM*check-EZ* software method (or other compliance option available under the code) to demonstrate compliance. State maps showing climate zones, prescriptive package tables for each zone, and instructions are provided separately from this guide. You must have the appropriate prescriptive package table for your building's climate zone to use this method. To demonstrate compliance, complete the *Envelope Compliance Certificate* included with this guide.

Air Leakage

All joints and penetrations in the building envelope that are potential sources of air leakage must be caulked, gasketed, weatherstripped, or otherwise sealed in an approved manner.

The following areas in the building envelope must be sealed:

- exterior joints around window and door frames
- areas between wall sole plates, floors, and exterior-wall panels
- openings for plumbing, electricity, refrigerant, and gas lines in exterior walls, floors, and roofs
- openings in the attic floor (e.g., where ceiling panels meet interior and exterior walls and masonry fireplaces)
- service and access doors or hatches
- all other similar openings in the building envelope.

Recessed-lighting fixtures must be gasketed and IC rated; i.e., rated for direct contact with insulation.

The code specifies maximum air leakage rates for manufactured windows and doors. Windows and doors certified by an accredited laboratory (such as the National Wood Window and Door Association [NWWDA] or the Architectural Aluminum Manufacturers Association [AAMA]) meet these requirements and are labeled. For noncertified windows and doors, check manufacturers' test reports to verify compliance with these air leakage requirements.

Frame Type	**Windows** (cfm per ft of operable sash crack)	**Doors** (cfm per ft of door area)	
		Sliding	**Swinging**
Wood	0.25	N/A	0.25
Aluminum	0.37	0.37	1.25
PVC	0.06	0.37	N/A

Maximum Allowed Air Leakage Rates

Building Component Certification

Insulation R-values and glazing and door U-factors must be clearly marked on building plans or specifications. If two or more different insulation levels exist for the same building component, record each level separately on the plans or specifications. For example, if the walls adjacent to an unheated warehouse have less insulation than the building's exterior walls, record both insulation levels.

You must provide component R-values and U-factors so compliance can be determined. These values may be provided on

- product labels - For example, the R-value of the insulation is often printed directly on the insulation or can be determined from a striping code. Window U-factors are often included on the manufacturer label posted directly on the window.
- contractor statements certifying the products they have installed - For example, the insulation contractor should certify the R-value of the installed insulation.

For blown or sprayed insulation, the initial installed thickness, settled thickness, coverage area, and number of bags used must be clearly posted at the job site. For components having a manufacturer's guaranteed R-value rating, thickness markers must be placed at least every 300 ft^2. For components without a manufacturer's guaranteed R-value rating, contact the Insulation Contractors Association of America for an approved way to ensure proper insulation levels are obtained.

Finally, check with your code enforcement official having jurisdiction for requirements on certifying building components.

Standard Insulation Thicknesses

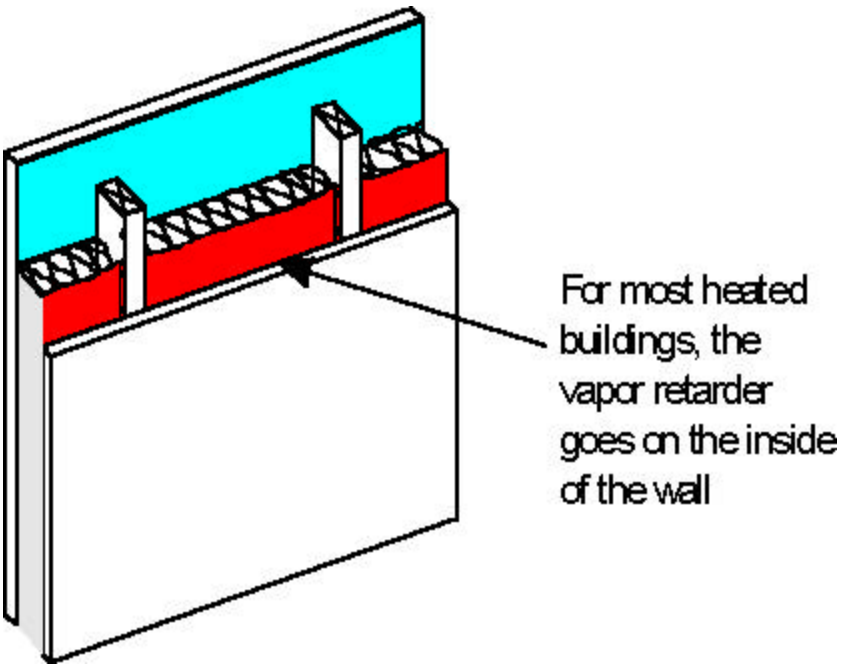
Insulation can be compressed if not properly installed. The insulation R-value is dependent on the installed thickness of the insulation. All COM*check-EZ* insulation

requirements assume the insulation is installed at its standard thickness. If insulation is compressed, the R-value is reduced and the building may not meet the requirements. This situation is of particular concern in metal building construction because of the way the insulation is installed to create a clean-finish appearance. The following table shows the R-values and standard thicknesses of fiberglass batts. However, when using an R-19 batt in a typical 2x6 wall, you can assume the full R-value of 19.

Insulation R-Value	Standard Thickness (in.)
R-11	3 ½
R-13	3 5/8
R-15	3 ½
R-19	6 ¼
R-21	5 ½
R-22	6 ¼
R-30	9 ½
R-38	12

Vapor Retarders

Except in specified climate zones, vapor retarders must be installed in all nonvented framed areas in ceilings, walls, and floors. Nonvented areas are framed cavities without vents or other openings to allow for free air movement. The vapor retarder must have a perm rating of 1.0 or less and must be installed on the warm-in-winter side of the insulation (between the insulation and conditioned space).



Location of Vapor Retarders

Vapor retarders are not required where moisture or its freezing will not damage materials or where other approved measures are taken to avoid condensation. These vapor retarder requirements do not apply in Climate Zones 1 through 7–roughly the warmest third of the United States.

[See the State Maps available with (or at the end of) these guides to determine the appropriate climate zone for your building.]

Insulation and Window Requirements

The COM*check-EZ* methods contain climate-specific envelope requirements for walls, windows, skylights, roofs, floors, and basement walls. The manual method prescribes insulation levels, glazing areas, and glazing U-factors. The software method provides additional flexibility because these requirements can be traded against each other.

The WWR is the gross window area divided by the gross wall area.

The gross wall area includes

- the opaque area of all above-grade exterior walls enclosing conditioned spaces (including above-grade portions of basement wall assemblies but excluding walls separating conditioned from unconditioned space)
- the area of the band joist and subfloor between floors
- the area of all doors and windows.

The gross window area includes the rough-opening area of the window, not just the transparent-glass area.

To determine if your proposed design complies with the climate-specific requirements

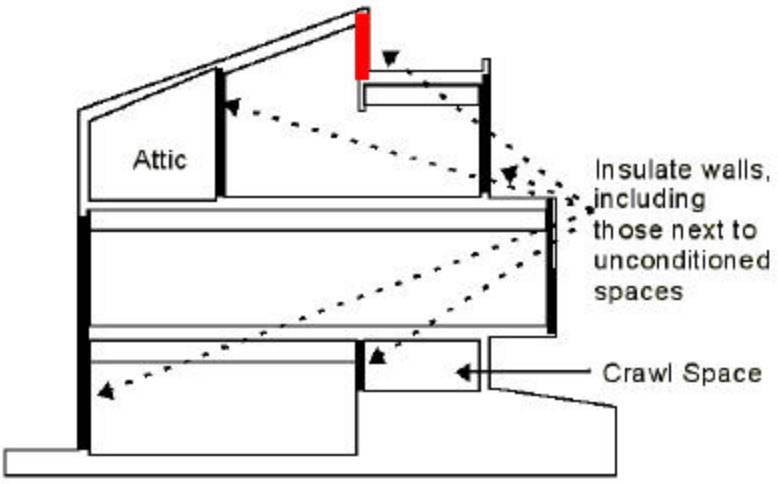
- determine the WWR category for your design (0-10%, 10-25%, 25-40%, 40-50%)
- determine the climate zone for your proposed building's location from the appropriate state map
- find the prescriptive package table for your building's climate zone
- select the package from the table that best fits your design's construction characteristics based on WWR
- find the corresponding requirements for walls, windows, skylights, roof, floors, and basement walls
- determine if your design complies based on criteria contained in the following sections.

You cannot use the manual method for buildings with WWR over 50%. For these buildings, use the COM*check-EZ* software or another compliance method permitted under the code.

Walls

Your design complies with the wall insulation requirement if the proposed wall insulation has an R-value equal to or greater than the requirement in the prescriptive package. Wall insulation requirements apply to both exterior and interior walls that separate conditioned

from unconditioned space. The wall type, WWR, and whether the wall is on the exterior or just separating conditioned from unconditioned space, may affect the wall insulation requirement.



Location of Wall Insulation

To demonstrate compliance, enter the R-value of the insulation to be installed in each wall component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for walls represent wall cavity insulation and/or continuous insulation (insulating sheathing), depending on the package selected. For example, if R-13 batt insulation is to be used with R-6 insulating sheathing, enter "R-13 + R-6" in the *Proposed R-Value* column.

All wall components with the same R-value may be combined and entered as a single component on the certificate, provided these walls are of the same construction class (i.e., wood, metal, masonry).

Concrete Masonry Unit Walls

Concrete masonry unit walls may be insulated by filling the empty core with perlite, vermiculite, or some other insulating material. In some cases, even with filled cores, these wall types require additional insulation.

Metal Building Walls and Roofs

Special attention to the design and construction of metal buildings is required to ensure these buildings meet the code requirements. Two key elements exist in metal buildings that are not found in other building classes–thermally broken connections between the purlin and metal roof sheet and compression of insulation behind wall girths and roof purlins.

COM*check-EZ* includes requirements for metal building walls and roofs. These requirements are specified in the "Walls Framed - Metal Framing" category and in the "Roofs Metal Purlin" category in the Prescriptive Packages. There are two classes of metal building roofs. One class uses traditional techniques that drape the insulation over the purlin and fasten the metal roof sheets through the insulation directly to the purlin. The second class requires that a thermal block be placed between the metal roof sheet and purlin.

A thermal block consists of foam blocks or other materials/techniques that prevent heat from migrating from the purlin directly to the metal roof sheet. Compressed fiberglass batt insulation does not qualify as a thermal block.

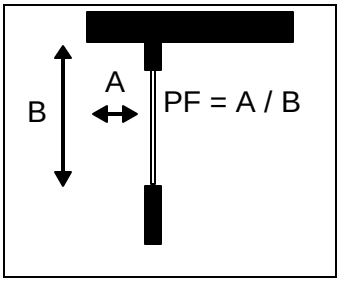
Windows

Your design complies with the window U-factor requirement if the proposed windows have a U-factor less than or equal to that in the prescriptive package. In most cases, the WWR will affect the window requirement.

A window U-factor is based on the interior-surface area of the entire assembly, including glazing, sash, and other framing elements. Center-of-glass U-factors cannot be used.

Your design must also have a Solar Heat Gain Coefficient (SHGC) less than or equal to that shown in the prescriptive package. The SHGC specifies the glazing's effectiveness in rejecting solar heat gain. SHGC is part of a system for rating window performance used by the National Fenestration Rating Council (NFRC). SHGC is gradually replacing the older index, shading coefficient (SC), in product literature and design standards. If you are using glass whose performance is listed in terms of SC, you may convert to SHGC by multiplying the SC value by 0.87. The SHGC requirement is affected by the projection factor (PF) of qualifying overhangs.

The projection factor is based on the ratio of the overhang depth to the overhang height above the window sill.



Projection Factor

Question
What is the projection factor of an overhang that extends 3 ft out and is 6 ft above the bottom window sill?
Answer
The projection factor is A divided by B. If A is 3 ft and B is 6 ft, the projection factor is 3/6 or 0.5.

For compliance, the SHGC cannot be modified to account for the effects of interior-shading devices. It can be modified for permanently attached devices that shade the exterior of the window. Examples of these devices include shade screens and architectural shade structures.

U-factors and SHGCs for glazing must be tested and documented by the manufacturer in accordance with the NFRC test procedure. Typical U-factor and SHGC values for windows and skylights are shown in the tables below. You may use these values to check compliance prior to selecting actual glazing products. However, the actual ratings for products installed in the building must meet or exceed (i.e., be no higher than) the values you assume in the compliance analysis.

Glazing Layers	Window Frame Type		
	Metal	Metal with Thermal Break	Wood or Vinyl
Single	1.2	1.1	1.0
Double	0.7	0.7	0.6
Double Low-e	0.6	0.6	0.5
Triple	0.6	0.5	0.5
Triple Low-e	0.5	0.5	0.4

Typical Window U-Factors

Glazing Layers	Glass Type		
	Clear	Tinted	Reflective
Single	0.8	0.7	0.5
Double	0.7	0.6	0.4
Double Low-e	0.7	0.6	0.4
Triple	0.7	0.5	0.4
Triple Low-e	0.7	0.5	0.4

Typical Glass SHGC Values

To demonstrate compliance, enter the proposed window U-factors in the *Proposed U-Factor* column and the proposed SHGC in the *Proposed SHGC* column on the *Envelope Compliance Certificate*.

Doors

Glazed doors must meet the same SHGC and U-factor requirements as windows from the prescriptive package tables. Opaque doors just need to meet the U-factor requirements for windows from the tables. If doors have been specified that do not meet these requirements, compliance must be demonstrated using the software or other approved method.

Skylights

Your design complies with the skylight U-factor requirement if the proposed skylights have a U-factor less than or equal to that in the prescriptive package. The packages restrict the total skylight area to 3% or less of the gross roof area.

A skylight U-factor is based on the interior-surface area of the entire assembly, including glazing, sash, curbing, and other framing elements. Center-of-glass U-factors cannot be used.

Glazing Layers	Skylight Frame Type		
	Metal	Metal with Thermal Break	Wood or Vinyl
Single	2.0	1.9	1.5
Double	1.3	1.1	0.9
Double Low-e	1.2	1.0	0.8
Triple	1.2	0.9	0.7
Triple Low-e	1.1	0.9	0.6

Typical Skylight U-Factors

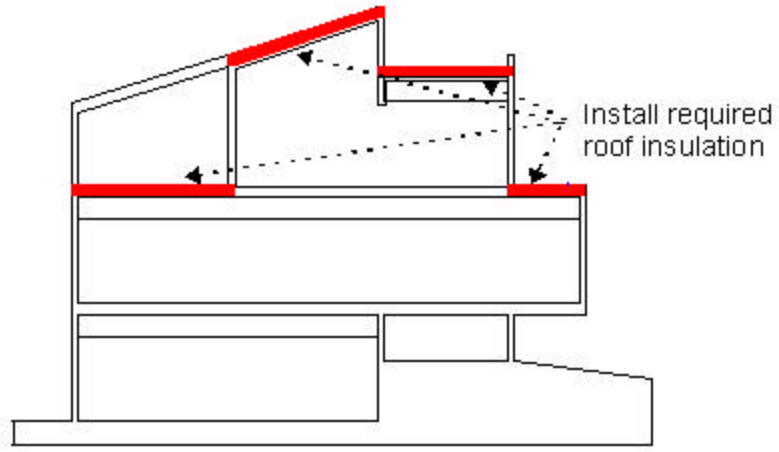
U-factors for skylights must be tested and documented by the manufacturer in accordance with the NFRC test procedure. If an NFRC U-factor rating is available for your skylight, you should use its BB-Size (i.e., 48 by 48 in.) rating.

To demonstrate compliance, enter the proposed skylight U-factors in the *U-Factor* column on the *Envelope Compliance Certificate*.

Roofs

Your design complies with the roof insulation requirement if the proposed roof insulation has an R-value equal to or greater than that in the prescriptive package. In some cases, the WWR will affect the roof insulation requirement.

Roof insulation in buildings with attics must be installed to allow for free circulation of air through the attic eave vents. To demonstrate compliance, enter the R-value of the insulation to be installed in each roof component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for roofs represent cavity insulation and/or insulating sheathing (depending on the package selected). For example, if R-19 batt insulation is to be used with R-4 insulating sheathing, enter "R-19 + R-4" in the *Proposed R-Value* column.



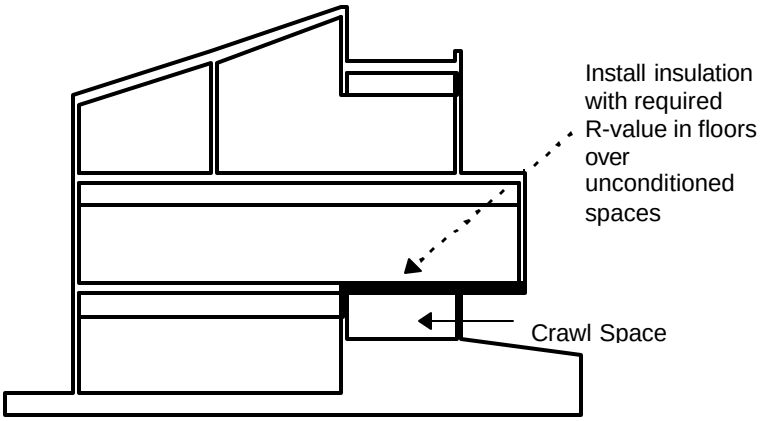
Location of Roof Insulation

All roof components with the same R-value and construction class may be combined and entered as a single component on the certificate.

Floors

Your design complies with the floor insulation requirement if the proposed floor insulation has an R-value equal to or greater than that in the prescriptive package. Floor insulation requirements apply where the underside of a floor is exposed to the outdoors or unconditioned space.

To demonstrate compliance, enter the R-value of the insulation to be installed in each floor component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for floors represent cavity insulation, spray-on insulation, and insulating sheathing (depending on the package selected).

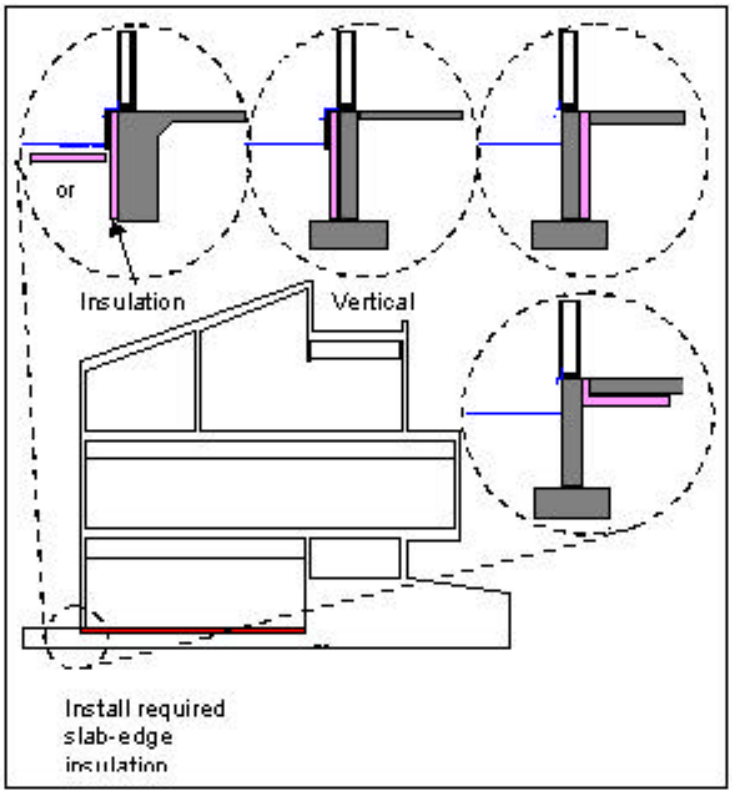


Location of Raised-Floor Insulation

All floor components with the same R-values and construction class may be combined and entered as a single component on the certificate.

Slab-On-Grade

In some cases, the edges of concrete slab floors must be insulated. The following diagram shows several common ways to effectively insulate a slab edge.

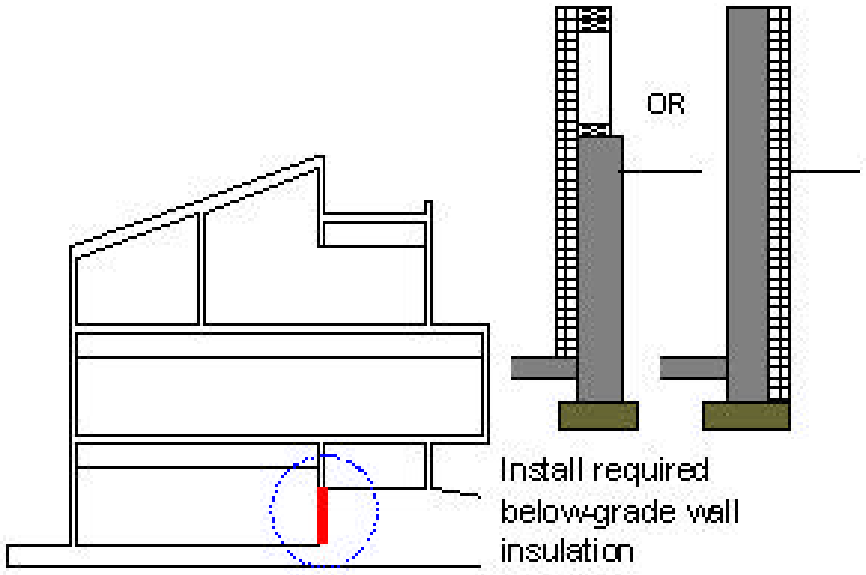


Location of Slab-Edge Insulation

Slab-edge insulation may be installed vertically or horizontally on the inside or outside of foundation walls. If installed vertically, it must extend downward from the top of the slab to the top of the footing (or 48 in., whichever is less). If installed horizontally, it must cover the slab edge and then extend horizontally (to the interior or exterior) for a minimum distance of 40 in.

Below-Grade Walls

In some cases, basement walls must be insulated. For purpose of this requirement, a wall is considered to be below grade when at least 85% of its surface area is in direct contact with the earth. The insulation must extend 10 ft below finish grade or to the level of the below-grade floor (i.e., the lowest floor), whichever is less. Your design complies with the basement wall insulation requirement if the proposed insulation has an R-value equal to or greater than that in the prescriptive package.



Location of Basement Wall Insulation

To demonstrate compliance, enter the R-value of the insulation to be installed in the basement wall component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for basement walls represent cavity insulation or insulating sheathing (depending on the package selected).

All basement wall components with the same R-value and construction class may be combined and entered as a single component on the certificate.

Completing Envelope Compliance Certificate

These instructions explain the information to include in the Envelope Compliance Certificate, identify the appropriate contact or reference if you have questions, and provide *EZ* tips for completing the certificate. A sample certificate is also provided. The instructions have numbered circles that correspond to those on the sample certificate. For code enforcement officials, *EZ* tips for plan check and field inspection are included at the end of this guide.

General Guidelines

For Documentation Authors: Provide all information in unshaded sections, entering "NA" if a particular requirement is not applicable; submit the completed certificate to the authority having jurisdiction with the building permit application package.

For Plan Checkers: Verify that proposed values listed on the certificate are consistent with the plans and specifications and with the requirements of this guide or the code.

For Field Inspectors: Inspect and approve building construction against each requirement in Section 3 of the certificate.

Prequalifying Project Design

Before using the *Envelope Compliance Certificate*, determine if your proposed design is qualified to use the COM*check-EZ* manual method to demonstrate compliance.

To determine if your design qualifies, calculate the WWR for the design using the following equation. If the design WWR exceeds 50%, or the prescriptive path cannot be followed in its entirety, a nonprescriptive code approach must be used. The COM*check-EZ* software provides an optional way to demonstrate compliance through a system performance path. Refer to the COM*check-EZ Software Compliance Guide* for instructions on using the software.

Gross Fenestration Area) Gross Exterior Wall Area X 100 = Design WWR%

Low Fenestration (WWR 0%-10%)

Medium Fenestration (WWR 10%-25%)

High Fenestration (WWR 25%-40%)

Very High Fenestration (WWR 40%-50%)

Sample Envelope Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

1	Project Name: **The Ultimate Pizza Palace**		Permit #: **B9901**
2	Address: **1234 Jobsite, USA**		Date: **12/16/00**
3	Owner/Agent: **Cris Doe**	Telephone: **(333) 337-2121**	Checked By: **B. Jones**
4	Documentation Author: **Jack Y. Smith, AIA**	Telephone: **(333) 333-3333**	Date: **1/20/01** For Department Use Only

Section 2 - General Information

5 Building Floor Area **12,500 ft²**

6 Window-Wall Ratio (WWR) (Gross Fenestration Area **12,500** ft²) Gross Exterior-Wall Area **4500** ft²) x 100 = Design WWR **15**%

7 Project Description ☒ New Construction ☐ Addition ☐ Alteration ☐ Unconditioned Shell

Section 3 - Requirements Checklist

8 **Air Leakage, Component Certification, and Vapor Retarder Requirements**

	Inspection Date	Approved By	Notes
All joints and penetrations are caulked, gasketed, weatherstripped, or otherwise sealed	4/15/01	AJ	No labels: must get mfr. spec sheets to verify NFRC window U-value testing. AJ 4/15/01
Windows, doors, and skylights certified as meeting leakage requirements	4/15/01	AJ	
Component R-values and U-factors are labeled as certified	4/15/01	AJ	
Vapor retarders installed	4/22/01	AJ	
Exception: Zones 2-7 in exempted states (listed on Page 3)	2nd insp		

Climate-Specific Requirements

	Description	Proposed R-Value	Minimum R-Value	Inspection Date	Approved By
9 Wall Type 1	**2x6 wood stud**	**R-13**	**R-13**	4/22/01	AJ
Wall Type 2	**8" CMU**	**R-5**	**R-5**	4/22/01	AJ
Wall Type 3					
Wall Type 4					
Roof Type 1	**Roof Deck**	**R-19**	**R-19**	4/25/01	AJ
Roof Type 2					
Roof Type 3					
Floor Type 1	**2x10 DF joist**	**R-25**	**R-25**	5/15/01	AJ
Floor Type 2	**Slab on grade**	**R-0**	**R-0**		

Reinspection: NFRC spec sheets and windows OK. AJ 4/16/01

	Description	Proposed U-Factor	Maximum U-Factor	Inspection Date	Approved By
10 Window 1	**Vinyl, 2-pane**	**.48**	**.50**	2nd insp (see note) 4/16/01	AJ
Window 2					
Window 3					
Skylight 1	**Vinyl, 2-pane**	**1.10**	**1.30**	4/15/01	AJ
Skylight 2					

	Exterior Shading		Proposed SHGC	Maximum SHGC	Inspection Date	Approved By
11 Window 1	Y / N	PF* **.25**	**.50**	**.60**	4/15/01	AJ
Window 2	Y / N	PF **.25**	**.60**	**.70**	4/15/01	AJ
Window 3	Y / N	PF				

*PF = projection factor

Skylights less than 3% of the Total Roof Area 2.2 % of Roof

Section 4 - Compliance Statement

The proposed envelope design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2000 IECC envelope requirements using COMcheck-EZ™ Version 2.1.

12 Principal Envelope Designer - Name	Signature	Date
Jack Y. Smith, AIA	Jack Y. Smith, AIA	10/5/00

NOTE: This form is required on project plans.

Section 1 – Project Information

1 **Project Name** - name used to identify the project. ? Contact owner/agent.

2 **Address** - project site address. ? Contact owner/agent.

3 **Owner/Agent** - overall project representative; may be owner, project manager, or design professional of record. ? Contact owner/agent.

4 **Documentation Author** - individual responsible for filling out this certificate. ? Contact owner/agent.

EZ Tips

- The design professional of record, if required, should stamp and sign plans, specifications, and subsequent revisions.

Section 2- General Information

5 **Building Floor Area** - total of all heated/cooled gross floor areas measured to outer wall surfaces; include lofts and mezzanines. ? Contact owner/agent.

6 **Window-Wall Ratio (WWR)** - gross area of windows as a percentage of gross exterior wall; determines the sets of values to use in the prescriptive packages. ? See pages 5-9.

7 **Project Description** - additions—add floor area or conditioning to space; alterations—change existing floor area and include expanded walls and ceilings. ? See pages 2-5.

EZ Tips

- An unconditioned space affidavit can provide a record of code exemption for future mechanical/electrical permits.

Section 3 - Requirements Checklist

8 **Air Leakage, Component Certification, and Vapor Retarder Requirements**

All joints and penetrations - seal all leakage points between conditioned spaces and unconditioned or exterior spaces. ? See page 2.

Windows, doors, and skylights - must have certification labels showing compliance with NWWDA or AAMA standards or equivalent manufacturer cut sheets certifying compliance with air leakage requirements. ? See page 3.

Component (wall, ceiling/roof, floor) R-values and fenestration U-factors - must be clearly labeled, certified, or have equivalent manufacturer cut sheets. ? See page 3.

Vapor retarders - install continuous vapor retarders with a maximum 1-perm rating in nonvented walls, ceilings/roofs, and floors on the warm-in-winter side of the insulation.

? See page 4.

EZ Tips

- Caulking used to seal around electrical wiring penetrations must be approved for this use.
- Porous fire-stopping materials do not fulfill air-sealing requirements; use materials approved for both purposes.
- Labeling documentation can be misleading; make sure it specifically cites compliance with NWWDA or AAMA standards.
- The Field Inspector checks and approves air leakage control (rough framing, final), component labeling (rough framing), and vapor retarder (insulation) requirements.

9 Climate-Specific Requirements - Walls, Roofs, and Floors

General Requirements - include only the insulation R-value. The Proposed R-Values must be equal to or greater than the Minimum R-Values taken from the prescriptive packages. Use more wall, roof, or floor types when different from those of Type 1.

? See pages 6-7, 9-10.

Wall Type 1 - describe framing material or CMU thickness; be consistent with the wall categories in the prescriptive packages.

? See pages 6, 11.

Roof Type 1 - describe framing or deck material and, if metal, whether a thermal break is present; be consistent with the roof categories in the prescriptive packages.

? See pages 9-10.

Floor Type 1 - describe deck/framing material; be consistent with the floor categories in the prescriptive packages.

? See pages 10.

EZ Tips

- The Documentation Author notes the minimum climate-adjusted R-value for the design WWR and inserts the Proposed and Minimum (required) R-Value(s) in the corresponding columns.
- The Plan Checker checks Minimum R-Values with the values in the prescriptive packages; checks cavity depths and insulation materials; and checks for consistency with wall, floor, and plan details.
- The Field Inspector checks the building envelope for (1) minimum insulation R-values, (2) framing cavity depth compatible with the insulation listing, and (3) insulation voids and compressions (rough framing, insulation).

10 Climate-Specific Requirements - Windows and Skylights

General Requirements - include only verifiable NFRC U-factors. Proposed U-Factors must be equal to or less than Maximum U-Factors. Use more window and/or skylight types when multiple types are specified.

? See pages 7-9.

Window 1 - describe glazing type, frame material, Low-E, and/or inert gas details; provide Proposed and Maximum U-Factors.

? See page 7.

Skylight 1 - describe glazing type, frame material, Low-E, and/or inert gas details; provide Proposed and Maximum U-Factors. Skylights cannot exceed 3% of roof area.

? See page 9.

EZ Tips

- The Documentation Author enters window and skylight descriptions and Proposed and Maximum (required) U-factor(s) in corresponding columns for the project design WWR (see pages 3-4).
- The Plan Checker verifies that proposed glazing meets the design WWR and is NFRC-tested
- The Field Inspector inspects installed glazing for (1) glazing descriptions, (2) NFRC labels listing the maximum U-factors for the installed products, or (3) product descriptions when labels are not present (rough-framing phase).

11 **Climate-Specific Requirements - Window Projection Factors [PF] and Solar Heat Gain Coefficients (SHGC)**

General Requirements - insert the PF, if any. The proposed SHGC must be based on tested values that are equal to or less than the Maximum SHGC. SHGC requirements may differ depending on the PF. Use more window and/or skylight types when multiple types of PF conditions are specified.

? See page 7.

Window 1 - insert PF and SHGC adjusted for PF.

? See page 7.

Skylight 1 - insert PF and SHGC adjusted for PF.

? See page 7.

EZ Tips

- The Documentation Author calculates and enters window design PF and SHGC.
- The Plan Checker verifies that proposed glazing meets minimum NFRC testing requirements and that proposed values are consistent with plans and specifications.
- The Field Inspector inspects installed glazing for (1) glazing descriptions and (2) NFRC labels listing maximum proposed SHGC or product descriptions when labels are not present (rough-framing phase). The Field Inspector also checks for shading devices if an SHGC credit was allowed because of external shading (PF).

Section 4 – Compliance Statement

12 **Principal Envelope Designer - Name** - If required by the code official, the documentation author or design professional of record must print his/her name, sign, and date the certificate in the boxes provided to acknowledge that the structure has been designed to meet 2000 IECC envelope requirements using COM*check-EZ* Version 2.1.

EZ Tips for Envelope Enforcement

Plan Check

- Verify accuracy of Window-Wall Ratio (WWR) calculation.
- Check the values listed for (1) Minimum R-Value, (2) Maximum U-Factor, and (3) Maximum SHGC and verify that they are consistent with the values in the prescriptive packages for the appropriate WWR.
- Verify that proposed values on the certificate are consistent with plans and specifications.
- Labeling documentation for fenestration products can be misleading; verify that the documentation cites compliance with NWWDA or AAMA standards and that the products will be labeled accordingly (for field inspector).
- Check cavity depths to verify that space requirements for insulation materials are adequate and consistent with details of wall, roof, and floor plans.
- Verify that the NFRC-rated U-factor of the proposed glazing does not exceed the maximum U-factor in the prescriptive package.
- If an SHGC credit for exterior window shading (PF) is claimed on the certificate, verify that shading devices (overhangs, exterior shade screens, and architectural shade structures) are consistent with plans.
- Verify that the principal envelope designer (design professional of record) signs the certificate and, if required, stamps/seals and signs plans, specifications, and subsequent revisions.
- Some jurisdictions use an Unconditioned Space Affidavit to track construction exempt from specific codes (such as an unconditioned shell) that may later require a new permit when the space becomes conditioned.

Field Inspection

- Verify that required air leakage control measures have been implemented (rough framing and final inspections), that labels required for specific components are present (rough-framing inspection), and that vapor retarders are present and properly installed (insulation inspection).
- Verify that porous fire-stopping materials are not used to fulfill air-sealing requirements; some materials are approved for both purposes (rough framing).
- Inspect the caulk used to seal around electrical wiring penetrations and verify that it is approved for this use (rough-framing inspection).
- Inspect the building envelope to verify (1) that installed insulation meets the minimum R-values listed on the certificate, (2) that the framing cavity meets space requirements for installed insulation materials, and (3) that no insulation voids or compressions are present (rough-framing inspection and insulation inspection).
- Inspect installed glazing to verify that descriptions and NFRC-label values for (1) Minimum R-Value, (2) Maximum U-Factor, and (3) Maximum SHGC are consistent with the values listed on the certificate (rough-framing inspection).
- If an SHGC credit for exterior window shading (PF) is claimed on the certificate, inspect the shading devices (overhangs, exterior shade screens, and architectural shade structures) and verify that they are consistent with plans (rough-framing inspection).
- Verify that the principal envelope designer (design professional of record), if required, stamps/seals and signs plans, specifications, and subsequent revisions.

Envelope Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

Project Name		Permit #
Address		Date
Owner/Agent	Telephone	Checked By
Documentation Author	Telephone	Date For Department Use Only

Section 2 - General Information

Building Floor Area

Window-Wall Ratio (WWR) (Gross Fenestration Area ___ ft^2) Gross Exterior-Wall Area ___ ft^2) x 100 = Design WWR ___%

Project Description ☐ New Construction ☐ Addition ☐ Alteration ☐ Unconditioned Shell

Section 3 - Requirements Checklist

Air Leakage, Component Certification, and Vapor Retarder Requirements	**Inspection Date**	**Approved By**	**Notes**
All joints and penetrations are caulked, gasketed, weatherstripped, or otherwise sealed			
Windows, doors, and skylights certified as meeting leakage requirements			
Component R-values and U-factors are labeled as certified			
Vapor retarders installed			
Exception: Zones 1-7			

Climate-Specific Requirements

	Description	Proposed R-Value	Minimum R-Value
Wall Type 1			
Wall Type 2			
Wall Type 3			
Wall Type 4			
Roof Type 1			
Roof Type 2			
Roof Type 3			
Floor Type 1			
Floor Type 2			

	Description	Proposed U-Factor	Maximum U-Factor
Window 1			
Window 2			
Window 3			
Skylight 1			
Skylight 2			

	Exterior Shading		Proposed SHGC	Maximum SHGC
Window 1	Y / N	PF*		
Window 2	Y / N	PF		
Window 3	Y / N	PF		

*PF = projection factor

Skylights less than 3% of the Total Roof Area **% of Roof**

Section 4 - Compliance Statement

The proposed envelope design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2000 IECC envelope requirements using COMcheck-EZ™ Version 2.1.

Principal Envelope Designer - Name	**Signature**	**Date**

NOTE: This form is required on project plans.

Mechanical Compliance

Mechanical Requirements

You can use COM*check-EZ*™ to demonstrate that your commercial or high-rise residential building design complies with the 2000 Edition of the IECC.

Mechanical Compliance Options

COM*check-EZ* offers two separate methods for showing compliance–a manual method and a software method. This Mechanical Compliance Guide contains the energy code requirements for mechanical systems and equipment, and instructions on how to manually demonstrate and document that your proposed design complies with code requirements.

This guide has three major sections – Simple Systems, Complex Systems, and Water-Heating Systems. Generally, you can use the Simple Systems section with single-zone systems but need to use the Complex Systems section if your building contains any multiple-zone systems. The Simple Systems section is shorter and less technical and therefore is the preferred approach for any buildings that qualify. The brief Water-Heating Systems section provides code requirements for service water-heating systems for all types of commercial buildings.

The COM*check-EZ* software offers an alternative compliance method. The software uses a "wizard" approach that enables you to readily generate a checklist of mechanical requirements applicable to your building design. Refer to the COM*check-EZ* Software Compliance Guide for instructions on using the software method.

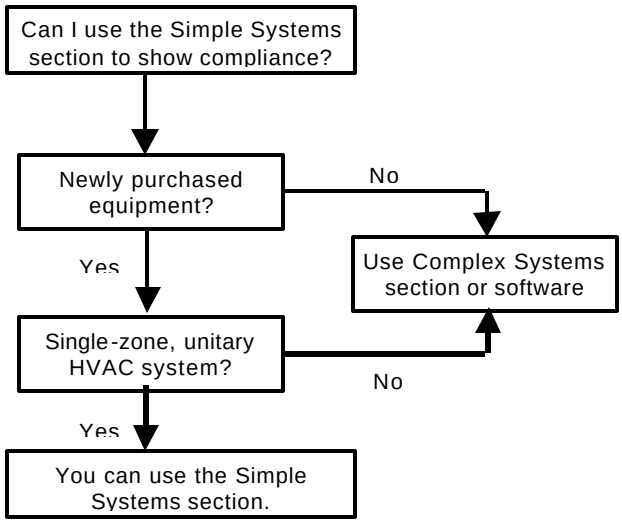
Demonstrating Compliance

To demonstrate compliance, indicate on your project plans equipment efficiencies, system controls, outdoor-air ventilation rates, duct insulation levels, duct sealing, and water-heating components that comply. Complete a *Mechanical Compliance Certificate* –either for simple or complex systems –provided with this guide and include it with the permit submittal materials.

Qualifying for Simple Systems Method

COM*check-EZ* provides a simple way to demonstrate compliance with energy code requirements. You can use this simple method if your design uses the following equipment types:

- cooling – new unitary-packaged, split-system or packaged terminal air conditioner or heat pump
- warm-air heating – new unitary-packaged, split-system or packaged terminal heat pump; new fuel-fired furnace or electric-resistance heater
- hydronic heating – 2-pipe hot water radiators, baseboard heaters, fan coils, or other individual terminal heating units with new central boiler and no cooling system installed in the building
- variable-air volume (VAV) changeover system if it ensures the required ventilation is continuously provided to each space.



You cannot use the *Simple Systems* section with the following equipment types:

- packaged VAV reheat
- built-up VAV reheat
- built-up single-fan, dual-duct VAV
- built-up or packaged dual-fan, dual-duct VAV
- 4-pipe fan coil system with central plant
- hydronic heat pump with central plant
- other multiple-zone or built-up systems
- all other hydronic space-heating systems
- any combination of different types of allowed systems such as hydronic heating and unitary-packaged cooling.

To determine compliance for equipment types not covered in the *Simple Systems* section, refer to the *Complex Systems* section of this guide, the COM*check-EZ* software, or other compliance method acceptable to your local building department.

Simple Systems

This section applies only to buildings that meet all of the qualifying criteria in the previous section *Qualifying for Simple Systems Method*.

To promote the use of energy-efficient mechanical systems and equipment in commercial and high-rise residential buildings, the energy code requires

- minimum equipment efficiency at peak- and (in some cases) part-load conditions
- acceptable levels of outdoor-air ventilation to ensure occupant comfort and health
- use of outside-air economizers where appropriate
- ducts that are insulated and sealed to minimize heating and cooling energy losses
- hydronic heating system features that reduce distribution losses and increase part-load efficiency.

Mechanical Equipment Efficiencies

The 2000 IECC requires that mechanical equipment meet minimum efficiency ratings. However, virtually all equipment types compatible with this Simple Systems section are covered by manufacturing standards and must meet these minimums to be sold in the United States. For this and other reasons, all new equipment can be assumed to meet or exceed these minimum equipment efficiency levels. You still need to indicate the proposed equipment efficiencies on the mechanical plans and project specifications.

Heating and Cooling System Control Requirements

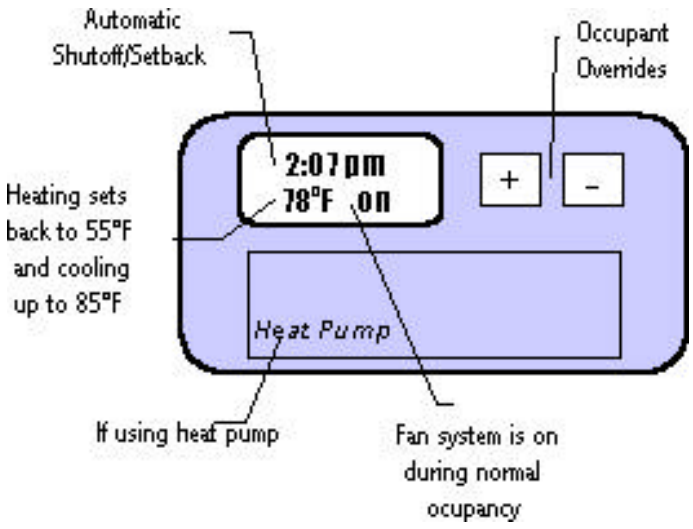
Thermostats are required for heating and cooling systems to control indoor temperatures. In some climates, air economizer systems are used to provide outdoor air for free cooling.

Thermostats

A thermostat is required in each zone to control heating and/or cooling. Thermostats must have the capability to automatically set back or shut down heating and cooling systems when appropriate. Thermostats must also have an accessible override so occupants can operate the system during off-hours. Heat pumps with supplementary electric-resistance heaters must have thermostats specifically designed for heat pump operation; i.e., to use resistance heaters only when the heat pump operating alone is inadequate to meet the load.

A programmable thermostat must be used to meet these requirements. These thermostats are available for heating only, cooling only, heating and cooling, and heat pump systems. They can set back or shut down the system during nights and weekends. In addition, occupants can temporarily override the thermostat and it will return to the original schedule without reprogramming.

Thermostats that control the temperature in residences, hotel/motel guest rooms, or areas where heating and/or cooling systems must operate continuously do not require a setback or shutoff control.



Thermostat Requirements

Air Economizer Systems

Air economizer systems take advantage of favorable weather conditions to reduce mechanical cooling by introducing cooler outdoor air into a building. They are common on packaged rooftop heating and cooling systems. When properly installed and maintained, these systems can reduce mechanical cooling by up to 75% in favorable climates.

The 2000 IECC requires air economizers capable of delivering at least 100% of the supply air directly from outdoors.

Typical economizer controls include a two-stage thermostat and an economizer controller using dry-bulb temperature or enthalpy, or a combination of both. A control is also included to prevent ice from forming on cooling coils. This control arrangement allows outdoor-air cooling, mechanical cooling, or outdoor-air plus mechanical cooling—a feature known as "integrated control." Field- and factory-installed economizers supplied by major equipment manufacturers include integrated controls.

The 2000 IECC requires the use of integrated-control economizers for all systems.

Exceptions to this requirement are

- buildings in climate zones 1a, 1b, 2a, 2b, 3b.
- cooling systems with a total cooling capacity less than 90,000 Btu per hour
- systems serving residential spaces, supermarkets, or hotel/motel guest rooms
- if the proposed equipment meets the minimum qualifying cooling energy efficiency ratio (EER) for economizer tradeoff (see table below).

Total Cooling Capacity of Equipment	Building Location		
	Zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15-19	Zones 3a, 4a, 7a, 8, 9b, 10b, 11b	Zones 4b, 5a, 5b, 6b, 7b
90,000 Btu/h to 134,999 Btu/h	N/A	11.4 EER	10.4 EER
135,000 Btu/h to 759,999 Btu/h	N/A	10.9 EER	9.9 EER
760,000 Btu/h or more	N/A	10.5 EER	9.6 EER

Minimum Energy Efficiency Ratio for Economizer Tradeoff

To identify the minimum EER necessary to trade off the economizer:

1. find the climate zone for your building location in the table
2. determine if this tradeoff is applicable to your zone
3. if so, find the appropriate cooling capacity of the proposed equipment and find the corresponding minimum EER.

Outdoor-Air Ventilation Requirements

Outdoor-air ventilation rates necessary to maintain indoor-air quality while minimizing energy use are currently being debated. The concerns of designers and health professionals regarding indoor-air quality were considered in developing this guide, thus outdoor-air ventilation and control requirements are included. However, the designer is ultimately responsible for recognizing building features that may cause poor indoor-air quality. Adherence to requirements in this guide cannot alone ensure that good indoor-air quality will be maintained.

All enclosed spaces where people are expected to remain for extended periods of time must be continuously ventilated with outdoor air. A space can be ventilated naturally or mechanically. These spaces must be ventilated according to the applicable building or mechanical code required by state or local statutes. In the absence of a local ventilation requirement, this compliance method requires that designers use Chapter 4 of the 1996 International Code Council (ICC) *International Mechanical Code* (IMC) or values from the table below.

In addition, spaces that may contain unusual sources of contaminants must be designed with enclosures to contain the contaminants. These spaces must also have local exhaust systems to directly vent the contaminants (see the state or local mechanical code or Chapter 5 of the IMC.)

Mechanical Ventilation

If your design is mechanically ventilated, it must

- meet minimum ventilation rates
- meet provisions for operating the system at those rates
- include dampers to prevent air infiltration during periods of building nonuse.

Minimum Outdoor-Air Requirements

Your design's heating and/or cooling system must supply the minimum-required outdoor air to a space (refer to your state or local code or Chapter 4 of the IMC for required rates). A supply- and return-air system or an exhaust system must supply the outdoor air. Refer to Chapter 4 of the IMC or use outdoor-air ventilation rates from the following table.

Building Type	Ventilation Rate (cfm per sq ft)
Auto Repair Workshop	1.5
Auditorium	2.25
Barber Shop	0.38
Bar, Cocktail Lounge, Casino	3.0
Beauty Shop	0.63
Cafeteria/Fast Food	2.0
Dry Cleaning	0.9
High-Rise Residential	Per IMC Section 403.3
Hotel Guest Room	30 cfm/room
Office	0.14
Retail Store (basement and street)	0.30
Retail Store (upper floors)/Mall	0.20
All Others	Per IMC Section 403.3

Required Outdoor-Air Ventilation Rates (IMC)

Ventilation Controls

When the heating and/or cooling system is controlled by a thermostat with a fan On/Auto switch, the switch must be set to the On position. Outdoor air is then supplied to the building whenever the system is operating. If a thermostat with a built-in time-switch is used, the thermostat must be capable of setting back or shutting off the fan during periods of nonuse.

Some ventilation systems are designed to supply outdoor-air quantities exceeding minimum levels. These systems must also be capable of reducing outdoor-air flow to minimum levels. Devices such as return ducts, mechanically or automatically operated control dampers, or fan volume controls can be used to reduce air flow.

Shutoff Dampers

Outdoor-air supply and exhaust systems with design air flow rates greater than 3000 cubic feet per minute of outdoor air must have dampers that automatically close while the equipment is not operating. This requirement will mainly affect dedicated outdoor-air supply systems in paint shops, restaurants, and auditoriums. This requirement does not apply to automatic dampers mandated by health and life safety codes.

Natural Ventilation

Windows, doors, louvers, or other openings to outdoor air can provide natural ventilation to interior spaces. Refer to your state or local code or Section 402 of the IMC to find minimum area requirements for above- and below-grade openings, adjoining spaces, and spaces containing contaminants. The codes typically require that a free opening of at least 4% of the floor area be available for natural ventilation.

Question
What is the window area required to ventilate a 30 x 32-ft classroom?
Answer
The area of the opening must be (30 x 32 ft) x 4% = 38.4 sq ft The actual window area must be at least 76.8 sq ft if only half the window opens. This calculation is based on free area. With framing, the actual window area is approximately 80 sq ft.

Refrigerant Pipe Insulation

For refrigerant pipe insulation, refer to the section *Pipe Insulation Requirements* in the *Complex Systems* section.

Duct Requirements

Ducts must be properly insulated and sealed to reduce energy loss.

Insulation

All supply- and return-air ducts and plenums must be insulated with a minimum of R-5 insulation when located in unconditioned spaces (e.g., attics, crawl spaces, unheated basements, unheated garages) and with a minimum of R-8 when located outside the building envelope. When located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned spaces by a minimum of R-8 insulation.

Exceptions:

- when located within equipment
- exhaust-air ducts
- when the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (8°C).

Sealing

Ducts are sealed to ensure quantities of air are not lost before they are delivered to the space. Flexible and metal ducts are common in small- to medium-size commercial buildings.

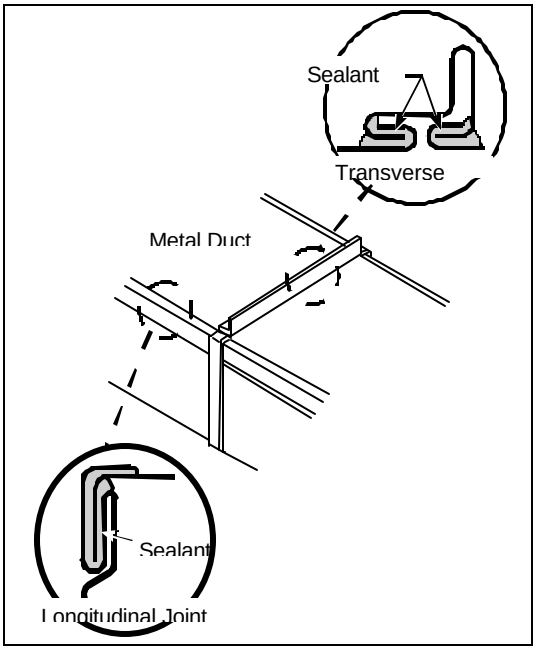
Properly sealing plenums, air handlers, and ducts is the key to eliminating leaks. In duct systems, all joints, longitudinal and transverse seams, and connections must be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes. Duct mastic-plus-embedded-fabric is the preferred flexible sealant. Tapes and mastics used to seal duct work must be listed and labeled in accordance with UL 181A or UL 181B.

Although the code does not require duct mastic, its use is strongly encouraged. Conventional duct tape must not be used except to seal the joints on duct access doors and air-handler panels.

Additionally, duct registers, grilles, and diffusers must be sealed to the gypsum board or other interior finish. Penetrations into the supply or return plenum (taps, takeoffs, and

starting collars) and any structural cavities used for air plenums or ducts must also be sealed.

In the diagram, an exterior-duct sealant is used to seal both transverse and longitudinal seams. Pressure-sensitive tape (duct tape) cannot be used as the primary sealant.



Sealing Metal Duct Transverse Seams

Hydronic Heating Requirements

The requirements listed in this section apply to systems that provide heating only through the use of individually controlled radiators or fan-coils and are served by a central hot water boiler. The following components are required on zonal heating systems:

1. thermostats meeting requirements for each individual heating zone
2. new equipment boilers and circulation pumps
3. pipe insulation - to reduce distribution and standby losses
4. variable-flow controls on the circulation pump or temperature reset controls for systems with capacities over 600,000 Btu per hour to increase efficiency during part-load operation.

For hydronic system part-load control requirements, refer to *Part-Load Control Requirements for Hydronic Systems* in the *Complex Systems* section.

(A blank compliance certificate for simple systems, instructions for using the certificate, and a filled-out sample can be found at the end of this Mechanical Guide.)

Complex Systems

This section is designed to provide a relatively simple process for demonstrating compliance with energy code requirements that apply to multi-zone HVAC systems. It is designed for use with any of the following system or equipment types:

- single-duct VAV distribution with zone reheat
- dual-duct VAV (either with a single supply fan or separate fans for heating and cooling ducts)
- constant-volume, single-zone with chilled water, hot water, or built-up direct expansion coils or electric or fuel-fired furnaces
- three-duct, constant- or variable-volume air distribution
- 4-pipe fan coil
- hydronic heat pump
- all types of central plant equipment, including electric- and heat-operated water chillers, boilers, and central refrigeration compressors serving one or more direct-expansion cooling coils.

This section can also be used with the following system types, although they are covered more simply under the *Simple Systems* section:

- packaged air conditioners – new unitary-packaged, split-system or packaged terminal air conditioner or heat pump
- packaged warm-air furnaces – new unitary-packaged, split-system or packaged terminal heat pump; new fuel-fired furnace or electric resistance heater.

Because of provisions that prohibit mixing hot and chilled water, you cannot use COM*check-EZ* for 2-pipe (systems that provide both heating and cooling) or 3-pipe fan coil or radiator systems.

You can use COM*check-EZ* for either of the multi-zone systems listed below only if all thermostatic control zones served by the system meet one of the exceptions to the requirement for VAV systems (see *Multiple-Zone System Requirements*)

- constant-volume, multiple-zone systems with reheat
- constant-volume, dual-duct systems.

To promote the use of energy-efficient systems and equipment in commercial and high-rise residential buildings, the energy code requires

- minimum equipment efficiency at peak- and part-load conditions
- controls that maximize air and hydronic system efficiency at part-load conditions
- controls that eliminate or minimize system operation during periods of nonuse
- water or air economizers on most systems
- minimum duct and pipe insulation levels and duct sealing measures
- efficient technologies and control strategies for variable-flow and multiple-zone systems

- acceptable levels of outdoor-air ventilation.

Equipment Efficiency Requirements

Heating and cooling equipment must meet the minimum efficiencies listed in the tables provided at the end of this guide. Equipment types not listed in these tables have no minimum efficiency requirements.

Federal manufacturing standards cover many of the equipment types listed in the tables, as is clearly noted. You can assume new equipment covered by these standards meet minimum efficiency requirements. Construction documents must include rated efficiencies for noncovered equipment and it is advisable to include ratings for all specified equipment. Enforcing jurisdictions may require that documentation, such as manufacturers' literature, be submitted in support of efficiencies reported in the construction documents.

Field-Assembled Equipment Requirements

Some complex systems use combinations of components to perform a cooling or heating function. For example, the system uses a separate heat exchanger and compressor for chilling water instead of a package water chiller. You must show that these systems meet the same requirements as the equipment listed in the tables for the comparable equipment type. Total energy input to the equipment must consider all the energy use of all components and accessories such as compressors, internal circulating pumps, condenser-fans, integral cooling water pumps, purge devices, crank case heaters, and controls. An enforcing jurisdiction may require that the registered engineer responsible for equipment specification stamp, sign, and date calculations.

Equipment Sizing

To determine the required size of heating and cooling equipment, designers must calculate the maximum heating and cooling loads for a building in accordance with the *1997 ASHRAE Handbook – Fundamentals*, and ensure that heating and cooling equipment is sized no larger than needed to meet those loads. The enforcing jurisdiction may require that the registered engineer responsible for equipment sizing stamp, sign, and date calculations and supporting documentation.

Some building owners want additional equipment (for example, an additional chiller of the same capacity) in case the primary equipment goes out of service. Standby equipment is allowed as long as it is separate equipment and is controlled to be always off when the primary equipment is operating.

Multiple units of the same equipment type with a combined capacity in excess of the calculated loads are also allowed if they are controlled to operate in sequence. In this case, additional units must be controlled to only operate as the load increases and cannot be controlled to turn on all at the same time.

System Control Requirements

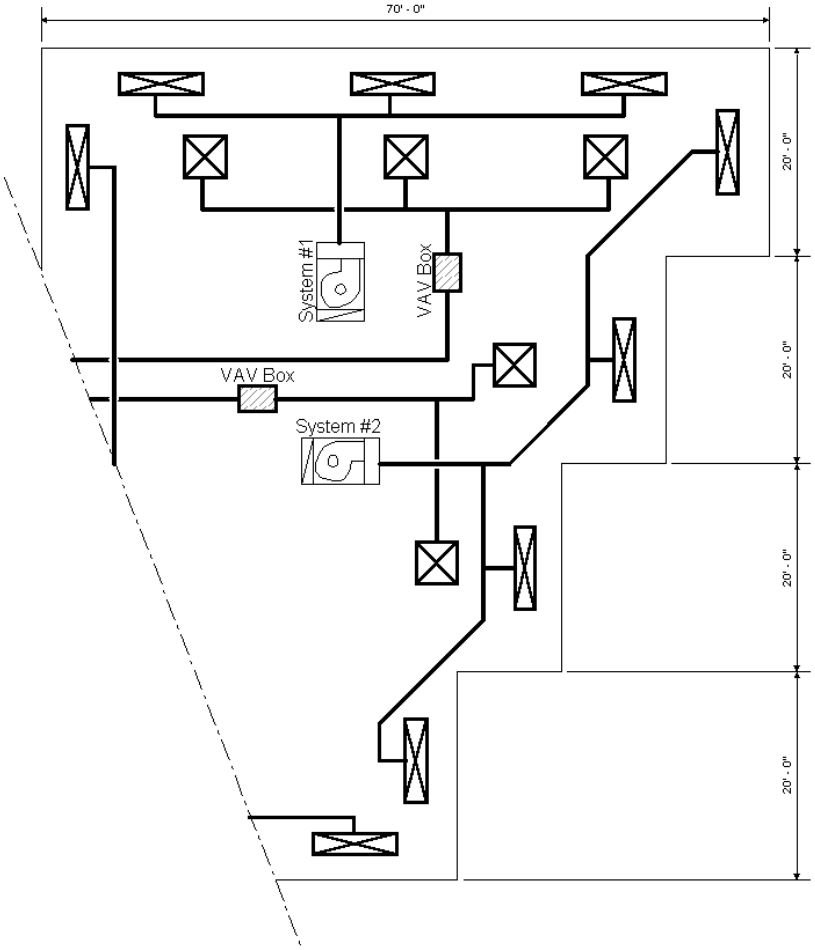
Temperature Controls

Each thermostatic control zone must be equipped with a thermostat or other device that controls heating and cooling to the zone and responds to environmental conditions within the controlled zone.

Exception: Perimeter Systems

Some complex mechanical systems have a separate system to handle envelope loads (mainly heat loss through the walls and windows and heat gain through windows), and serve interior spaces with a separate system. Individual zone controls are not required for perimeter systems if the controls for the perimeter system meet the following conditions:

- at least one temperature control must be installed for each perimeter area with exterior walls facing one orientation for 50 contiguous feet or more
- the thermostatic system control must be located within the space being served by the system.



System #1: At least one temperature control within the controlled space must be installed since the contiguous length of the building facade faces one orientation and is greater than 50 feet in length
System #2: All supply air outlets may be controlled with one controller within the space. Though the building facades of the spaces served by this system face different orientations, none is 50 feet or more in length.

Independent Perimeter System

Heat Pump Thermostats

Thermostats for air-to-air heat pumps must be specifically designed for heat pump operation. The thermostat must use the compressor as the first stage of heat and electric-resistance heat as the second stage. Controls must automatically prevent the operation of

the supplementary electric-resistance heat when the heating load can be met by the heat pump alone.

Thermostat Deadband Requirements

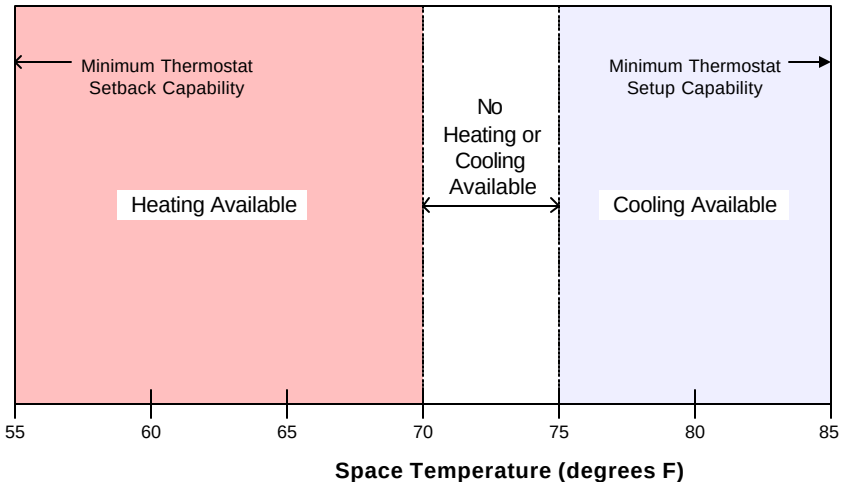
Thermostats that control both heating and cooling must be capable of having a "deadband" or range of temperature of at least 5°F where no heating and cooling is available. (Exception: thermostats requiring manual changeover between heating and cooling modes.)

Automatic System Controls During Periods of Non-Use

Single-zone systems and each zone served by multiple-zone systems must have controls that automatically reduce heating and cooling use during periods of non-use. Automatic controls can be time clocks that shut down systems or zones, time-controlled automatic setback controls, or occupancy sensors. Time controls and automatic time clocks must

- be able to start and stop systems, or turn on and shut off the supply of heating and cooling to each zone, for seven different day schedules per week
- retain programmed set points and time settings for at least 10 hours during power outages
- include or be installed in conjunction with a manual override that allows occupants to turn heating and cooling on for up to two hours during periods when the heating and cooling would otherwise be automatically off.

Thermostatic controls must be able to automatically set up the cooling set point to at least 85°F and set back the heating set point to a temperature no greater than 55°F.



Typical Thermostat Deadband and Required Setback/Setup Capabilities

Outside-Air Shutoff Controls

Even when a building is unoccupied and ventilation fans are not operating, outside air entering the building can significantly change the indoor temperature and humidity. This change in temperature and humidity can cause unnecessary energy use when the building is reoccupied and the mechanical systems are restarted. All supply- and exhaust-air systems must include a way to automatically close outside-air intakes when mechanical ventilation fans shut off. In smaller fan systems (less than 5,000 cfm), gravity dampers or dampers weighted to close when air is not moving through them are common. On larger systems, electric motors or pneumatic actuators are typically used to open and close

outside-air dampers. Systems with total air volume of 3,000 cfm and less are not required to have automatic outside-air shutoff controls.

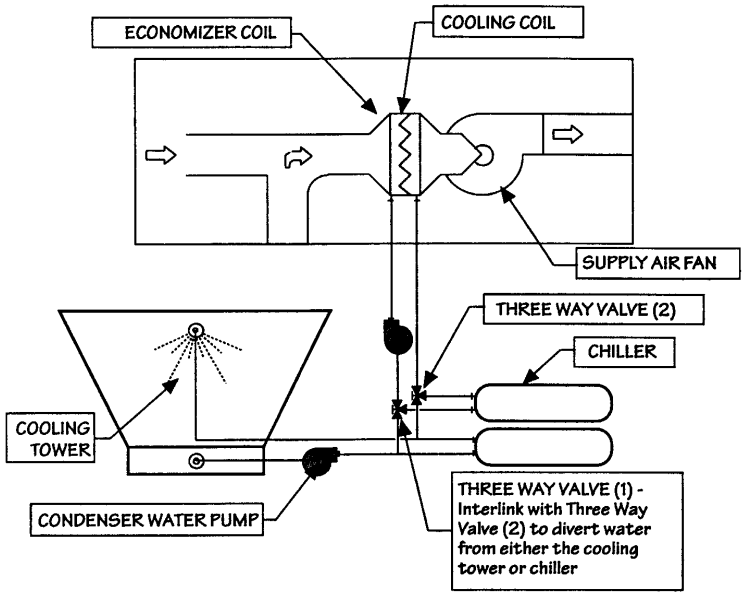
Cooling with Outdoor Air (Economizers)

All systems with supply-air quantities greater than 3,000 cfm and nominal cooling capacities greater than 90,000 Btu per hour must be equipped with an air economizer, or meet one of the economizer exceptions described in the Simple Systems section. Alternatively, complex mechanical systems may be equipped with water economizers designed to meet the design cooling load calculated as follows:

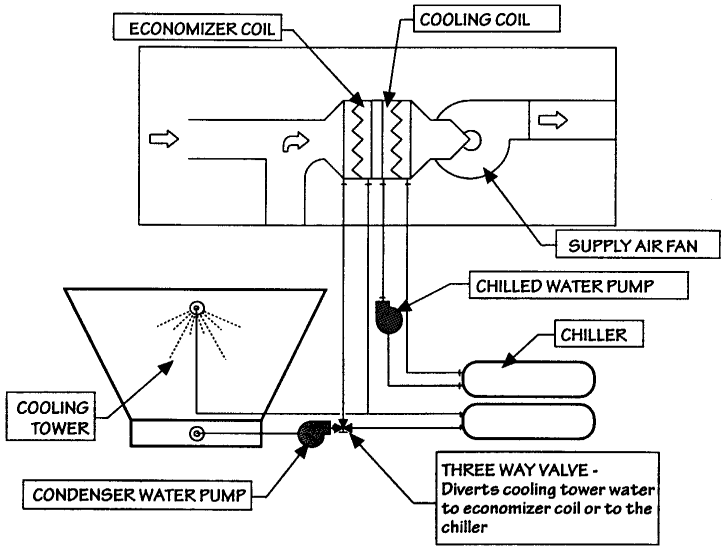
- cooling loads calculated according to the Equipment Sizing section
- water economizer outdoor operation temperatures of 50°F dry-bulb and 45°F wet-bulb.

The enforcing jurisdiction may require that the engineer responsible for system design authenticate and submit water economizer designs and supporting documentation.

The following figures show the most common types of water economizer systems:



Direct Water Economizer System



Indirect Water Economizer System

Variable-Flow Fans

Fans capable of varying their airflow are common on systems serving multiple thermostatic control zones and are sometimes used in exhaust applications. These fans must use one of the following airflow control methods:

- a mechanical adjustable-speed drive, which usually varies air flow by varying the diameter of one of the pulleys in the motor/belt drive system for the fan
- an electrical adjustable-speed drive, which uses electronic controls to vary the speed of the fan motor
- a vane-axial (or propeller style) fan with variable-pitch blades
- other variable-flow technologies that limit fan power to 50% of peak design fan power when air flow is 50% of design flow rate and static pressure is one-third of peak design static pressure. (An enforcing jurisdiction may require that calculations, data, or manufacturers' literature be submitted to document compliance using this method.)

Hydronic System Requirements

Systems with hydronic heating for both heating and cooling must have separate supply and return lines for hot and chilled water. The following types of hydronic piping systems are not allowed:

- 2-pipe systems, or systems that can supply and return hot or chilled water through the same piping system
- 3-pipe systems, or systems that have separate hot and chilled water supply piping but have a common return line.

Except as needed for humidity control, hydronic systems must have controls capable of preventing simultaneous supply of hot and chilled water to the system.

Part-Load Control Requirements for Hydronic Systems

Most systems operate at peak-load only during a small portion of the heating and cooling seasons. The energy code requires one of the following approaches for increasing hydronic heating and cooling system efficiency during part-load operation:

1. Water Temperature Reset – Using this approach, controls must be installed to decrease the temperature of the water leaving the heating plant as the overall demand for heating decreases, and increase the temperature of the water leaving the cooling plant as the overall demand for cooling decreases. Controls must be capable of decreasing (or increasing) water temperature by at least 25% of the difference between the design supply and return water temperatures.

Question
What is the reset requirement for a hot water distribution system if the design water temperature is 160°F and the design return temperature is 120°F?
Answer
The minimum amount of reset is (160°F – 120°F) x 25% = 10°F Therefore, controls must be able to reset the water temperature to 160°F – 10°F = 150°F

2. Variable Flow – Using this approach, controls must be installed that will reduce the flow of water as the overall demand for heating (or cooling) decreases. Acceptable methods for reducing flow are a) variable-frequency drives on pumps, which vary the speed of the pump; b) multiple, staged pumps, which vary the number of pumps used to circulate water; or c) control valves, which modulate to vary the flow of water.

Multiple-Zone System Requirements

Most larger buildings have HVAC systems that can heat and cool multiple independently controlled zones at the same time. Commonly called multiple-zone systems, these systems typically will reheat cool air, recool warm air, or mix warm and cool air to meet individual zone temperature requirements. Multiple-zone systems must have VAV controls capable of reducing the supply of warm (or cool) air to any zone before reheating, recooling, or mixing warm and cool air streams occurs.

Under some conditions, simultaneous heating and cooling is allowed without the need for individual VAV controls at the zone. The six exceptions below permit the use of constant-volume reheating, recooling, or mixing for individual zones. Except for Exception 6, these exceptions are not intended to allow the installation of constant-volume, multiple-zone systems, but rather to allow individual zones to have constant volume with reheating, recooling, or mixing on an otherwise complying VAV system.

Exception 1 – Zone Pressurization Requirements

If VAV operation will create unacceptable pressure relationships between a sensitive zone and other zones, simultaneous heating and cooling is allowed without VAV, but only for the sensitive zone.

Exception 2 – Site-Recovered or Site Solar Energy

Constant volume with reheating or mixing is allowed if 75% or more of energy for reheat or warm-air mixing is from any of the following sources:

- site-recovered energy such as heat recovery coils on an exhaust-air system or water chiller condenser
- site-generated solar energy such as solar water-heating collectors or photovoltaic panels.

Exception 3 – Special Humidity Requirements

In zones where specific humidity levels must be maintained for noncomfort purposes, simultaneous heating or cooling is allowed without VAV operation. Examples include areas of museums where sensitive materials are displayed or stored, or areas for manufacturing processes where precise humidity ranges are necessary. In these cases, the exception applies to the special zone and not to the entire system.

Exception 4 – Less than 300 cfm Zone Supply Air

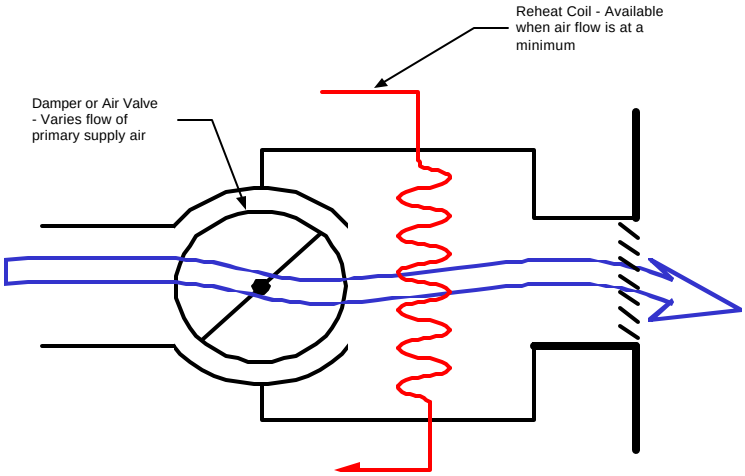
If the supply-air quantity to a zone is less than 300 cfm, simultaneous heating or cooling is allowed without VAV operation. This exception allows reheat to be used for small subzones of a larger zone. This exception is available only with air-handling systems serving multiple zones. It cannot be used to permit constant-volume, single-zone systems with subzone reheat.

Exception 5 – Ventilation Requirements

In some cases, mechanical codes (e.g., the *International Mechanical Code*) require that 100% outside air be supplied to a zone. VAV controls are not required for zones with 100% outside-air requirements.

Exception 6 – Sequencing Heating and Cooling to the Zone

VAV controls are not required if zone and system controls can sequence the supply of heating and cooling energy to the zone so that simultaneous heating and cooling never occurs. For example, a three-duct air distribution system consists of separate ducts for return air, cool air, and warm air. Zone controls will mix warm air with return air and cool air with return air but never warm air with cool air.



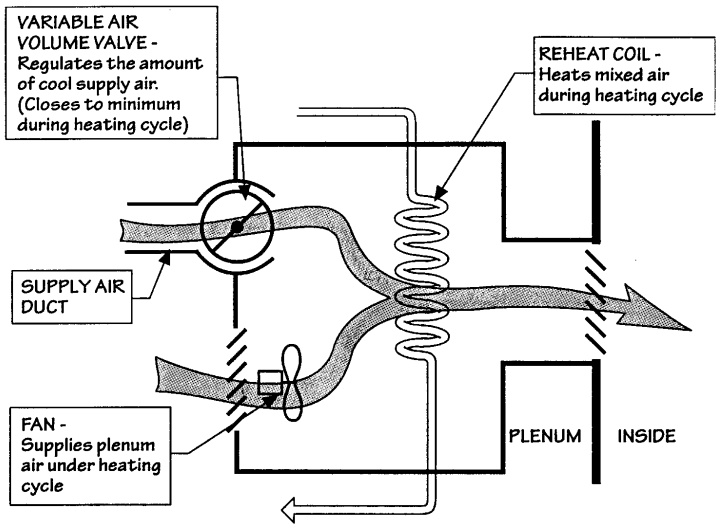
Nonfan-Powered VAV Box

Other Requirements for Multi-Zone Systems

In addition to the requirement for VAV zone controls, multi-zone systems must meet applicable requirements described below, depending on the distribution system design and the total number of supply fans.

Single-Duct VAV Systems

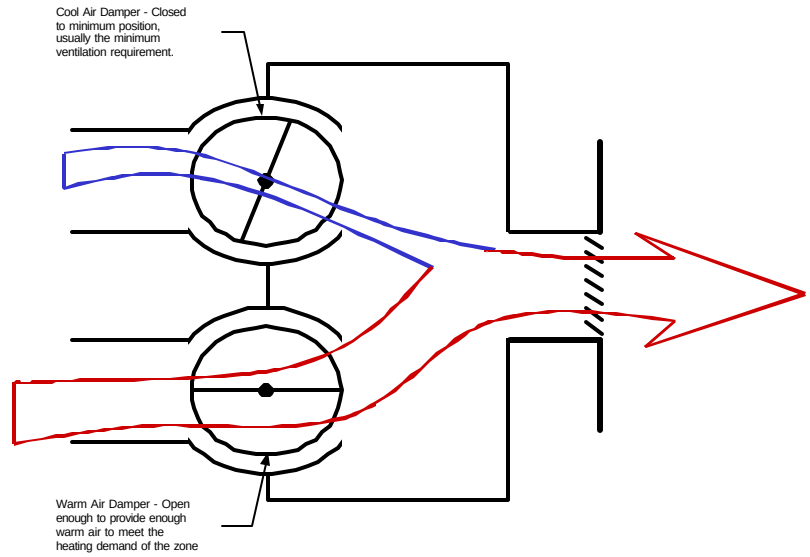
Single-duct VAV systems use a single supply-air duct with branches to individual zones. Thermostatically controlled terminal units are then used to vary the flow of air to the zone, and reheat or recool the air if necessary to meet the environmental control requirements for a zone. Single-duct VAV terminal units must be capable of reducing the supply of primary supply air to the zone to a minimum before reheating or recooling can occur. Single-duct VAV terminal units may also be equipped with a fan to draw air from a return-air plenum to for additional heat. The figures below show fan- and nonfan-powered VAV terminal units and their required features.



Fan-Power VAV Box

Dual-Duct VAV Systems

Dual-duct systems provide two separate supply air streams –cool air and warm air–that are mixed in each terminal unit and supplied to the zone as a single air stream. The system can have a single fan for both supply-air ducts or a separate fan for each duct. Dual-duct zone terminal units must be capable of reducing the air supply from one duct to a minimum prior to mixing with the other duct. These units require a damper or other way to reduce the airflow, as well as controls that prevent mixing with the other air stream until the minimum is reached. The figure below provides a schematic of a dual-duct terminal unit.



Dual-Duct VAV Mixing Box in Heating Mode

Dual-Duct and Mixing Systems with One Fan, Economizer Requirements

Single-fan, dual-duct systems use a single supply fan to blow air over two separate coils – one for heating and one for cooling. If an air economizer is used, outside air rather than return air is passed through the heating coil, thereby increasing energy use for heating. To avoid this additional energy use, dual-duct and other mixing systems (such as three-duct systems) with single supply fans cannot be equipped with air economizers. With no air economizer, only return air and minimum outside ventilation air need to be heated.

To meet economizer requirements with these systems, a water economizer must be installed. If the water economizer uses an additional cooling coil in the supply-air stream, then this coil must be installed in the system's cool-air duct and not in the return- or mixed-air portion of the ductwork.

Multiple-Zone Systems – Supply-Air Temperature Reset

An important way to minimize the use of mechanical cooling or heating energy in multiple-zone systems is to raise the cooling supply-air temperature (or lower the heating supply-air temperature) during periods when cooling and heating loads are not at their design peak. Multiple-zone systems must have controls capable of resetting the cooling and heating supply-air temperatures. The supply-air temperature must be reset by at least 25% of the difference between the design supply-air temperature and the design room temperature. For example, if the design supply-air temperature for a system is 55°F and the design space temperature for cooling is 75°F, the system must be capable of resetting the supply-air temperature up by 25% of 75 minus 55, or 5°F.

While many control strategies exist for meeting this requirement, the three most common methods are described below. Regardless of the control method, the enforcing jurisdiction may require additional documentation, such as manufacturer's literature or control diagrams to demonstrate compliance with reset requirements.

Method 1 – Supply-Air Reset Warmest (Coldest) Zone

Method 1 requires that zone thermostats for a system be connected to a central controller. With this method, a controller identifies the highest (or lowest) thermostat signal, which corresponds to the zone with the largest cooling (or heating) demand, and then controls the system supply-air temperature to meet the load in that zone.

Method 2 – Supply-Air Reset Reference Zone

Method 2 requires that the thermostat or temperature sensor for a representative zone be connected to the controller for supply-air temperature. A representative zone is often used when the supply-air temperature operates within a fixed range (such as from 55°F to 60°F). In this case, the reference zone is usually selected because it is expected to require the lowest supply-air temperatures for cooling or the highest supply-air temperatures for heating.

Method 3 – Supply-Air Reset Outside-Air Temperature

Method 3 requires that an outside-air temperature sensor be connected to the controller for the reference zone. Method 3 is most commonly used with heating systems where loads will vary closely with changes in outside temperature. Using this method, as the outside-air temperature drops (or rises) the supply-air temperature is reset up (or down). This method is sometimes used for cooling systems if the supply-air temperature operates within a narrow range (such as 55°F to 60°F).

Ventilation Requirements

Refer to the *Simple Systems* section for minimum outside-air ventilation requirements.

Duct Requirements

Refer to the *Simple Systems Duct Requirements* section for duct insulation, sealing, and installation requirements. In addition, all ducts designed to operate at static pressures in excess of 3 inches of water column must be leak-tested in accordance with methods published by the Sheet Metal and Air Conditioning Contractors of North America (SMACNA). A report and certificate must be submitted demonstrating that representative sections totaling at least 25% of the duct area have been tested and that all tested sections meet the duct-sealing requirements.

Leak tests and reports must demonstrate that the duct system meets the following criterion:

$$F < 6 \times P^{0.65}$$

where F = the measured leakage rate in cfm per 100 square feet of duct surface

P = the static pressure used in the test.

0.65 = the exponent (or power) to which the static pressure is raised in this equation

For example, the maximum leakage rate for a duct section operating at 4 inches water column static is

$6 \times 4^{0.65}$ or 15 cfm per 100 square feet of duct surface area.

Pipe Insulation Requirements

Pipe insulation requirements depend on the fluid type and nominal pipe diameter. The following table shows pipe insulation requirements based on an insulation thermal conductivity of 0.27 Btu·in/(h·ft^2·°F) [roughly R-4 per inch]:

Fluid	Pipe Diameter (in.)	
	not greater than 1.5	greater than 1.5
Steam	1.5	3.0
Hot Water	1.0	2.0
Chilled Water, Brine, Refrigerant	1.0	1.5

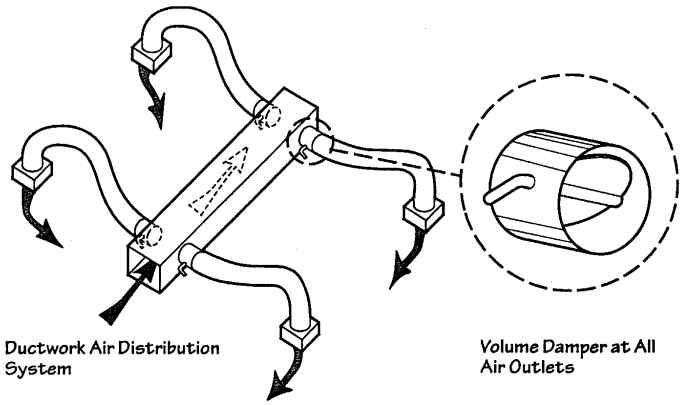
Insulation is not required with the following types of piping:

- factory-installed piping within HVAC equipment that has been tested and rated in accordance with a referenced test procedure to determine equipment efficiency
- piping conveying fluids having design operating temperatures between 55°F and 105°F
- piping conveying fluids that have not been heated or cooled through the use of fossil fuels or electric power
- runout piping no longer than 4 feet and no greater than 1 inch in diameter installed between the control valve and heating or cooling coil in an HVAC unit.

Air System Balancing

Proper system design and equipment selection is essential for long-term functionality and energy efficiency of mechanical systems. All systems need some type of verification in the field (both at start-up and periodically throughout the life of the building) to ensure they are operating as intended.

To facilitate field verification, the energy code requires that duct systems be equipped for easy testing and balancing after installation. Each supply-air outlet and zone-air terminal device must be equipped with balancing dampers, air valves, or other means for balancing. Balancing dampers that are integral to supply-air diffusers are acceptable for supply-air outlets.



Air Balancing Device

Hydronic Systems Balancing

To facilitate proper balancing and long-term efficient operation of hydronic systems, all hydronic terminal devices must be equipped with balancing valves or other means of hydronic system balancing.

Manuals and System Documentation

The code requires building plans, specifications, or other construction documents to require the mechanical contractor to provide an operating and maintenance manual to the building owner. This manual must include at least the following information about the design and intended operation of all mechanical systems in the building:

- equipment capacity (input and output) and required maintenance items and their required service interval
- equipment operation and maintenance manuals
- HVAC system control maintenance and calibration information, including
  - wiring diagrams
  - schematics
  - control sequence descriptions.

  Desired or field-determined set points must be permanently recorded on control drawings, at control devices, or, for digital control systems, in programming comments.
- a complete narrative of how each system is intended to operate.

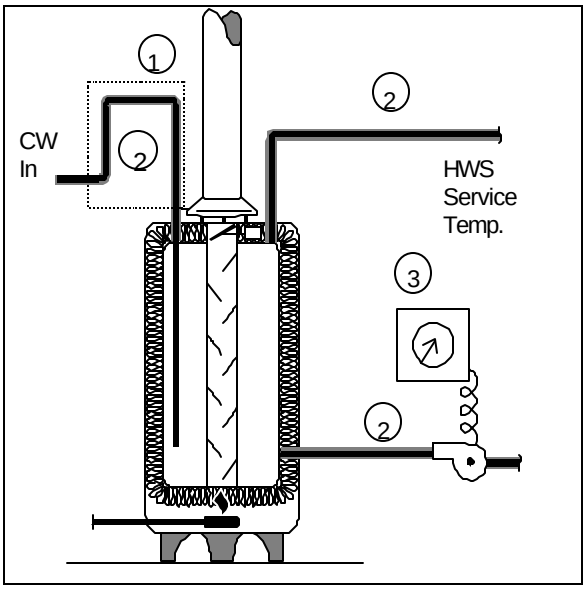
(A blank compliance certificate for complex systems can be found at the end of this Mechanical Guide.)

Water-Heating Systems

This section contains code requirements for service water-heating systems and equipment, and instructions on how to manually demonstrate that your proposed design complies with these requirements.

The requirements listed in this section apply to service and domestic water-heating systems. They do not apply to systems used for comfort heating or to systems designed to meet manufacturing, industrial, or commercial process requirements. The following components are required on water-heating systems (components shown in the following diagram by number):

1. heat traps - to reduce standby losses
2. pipe insulation - to reduce distribution and standby losses
3. circulation loop temperature control - to reduce distribution losses.



Water-Heating System Requirements

Equipment Efficiency Requirements

Heating and cooling equipment must meet the minimum efficiencies listed in the table provided at the end of this guide. Equipment not listed in these tables has no minimum efficiency requirements.

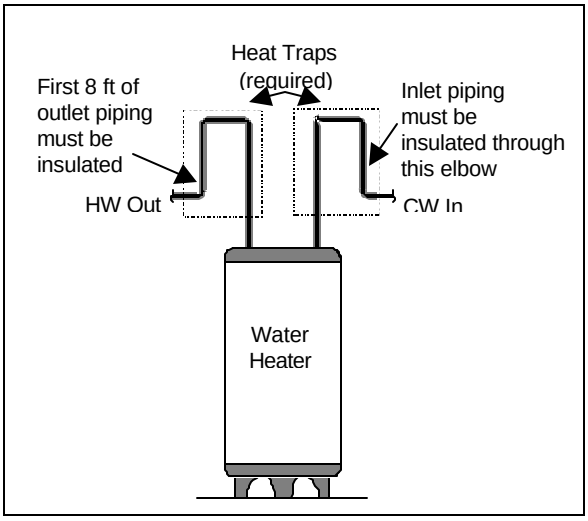
Federal manufacturing standards cover all of the equipment types listed in the table. Therefore, you can assume that any new service water-heating equipment will meet minimum efficiency requirements. Any reused equipment may not meet these requirements. Construction documents should include efficiency ratings for all service water-heating equipment.

Heat Traps

Heat traps stop hot water from rising into the distribution pipes and forming a natural convection loop.

Heat traps are required in the inlet and outlet piping of noncirculating water heaters. Some water-heating equipment has integral factory-installed heat traps. For equipment without integral factory-installed heat traps, heat traps must be purchased and installed in the inlet and outlet connections or field-fabricated by creating a loop or inverted U-shaped arrangement of the inlet and outlet piping.

Heat traps are not required on circulating systems.



Field-Fabricated Heat Traps

Pipe Insulation

The following pipe insulation levels are required:

- 1 in. on circulating water-heating systems
- ½ in. on the first 8 feet of outlet piping from any constant-temperature noncirculating storage system
- ½ in. on the inlet piping between the storage tank and a heat trap in a noncirculating storage system.

Circulation Loop Controls

Automatic time-switch controls must be installed to shut down the pump on circulating water-heating systems during periods of nonuse.

Demonstrating Compliance

To demonstrate compliance, indicate on your project plans the equipment efficiencies, system controls, and other water-heating components that comply. Also, fill in applicable items under *Water Heating Systems* on the *Simple Systems Certificate*. Blank copies of these certificates appear at the end of this guide.

Completing Mechanical Compliance Certificate for Simple Systems

These instructions explain the information to include in the COM*check*-*EZ* Mechanical Compliance Certificate for Simple Systems, identify the appropriate contact or reference if you have questions, and provide *EZ* tips for completing the certificate. A sample certificate is also provided. The instructions have numbered circles that correspond to those on the sample certificate. For code enforcement officials, *EZ* tips for plan check and field inspection are included at the end of this guide.

General Guidelines

- **For Documentation Author** - provide all information in unshaded sections, enter "NA" if a particular requirement is not applicable; submits the completed certificate to the authority having jurisdiction with the building permit application package.
- **For Plan Checker** - verify that proposed values listed on the certificate are consistent with the plans and specifications and meet the requirements in this guide.
- **For Field Inspector** - inspect and approve building construction against each requirement in Section 3 of the certificate.

Sample Simple Mechanical Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

1	Project Name: **The Ultimate Pizza Place**		Permit #: **M9958**
2	Address: **1234 Jobsite, USA**		Date: **12/16/00**
3	Owner/Agent: **Cris Doe**	Telephone: **(333) 337-2121**	Checked By: **B. Jones**
4	Documentation Author: **William A. Brown, PE**	Telephone: **(333) 333-1234**	Date: **1/20/01** For Department Use Only

Section 2 - General Information

5 Building Floor Area **12,500 ft²**

6 Project Description ☑ New Construction ☐ Addition ☐ Alteration ☐ Unconditioned Shell

Section 3 - Requirements Checklist

7

Heating and Cooling System Controls	Inspection Date	Approved By	Notes
One solid-state setback thermostat with occupant override per zone	5/20/01	AJ	Supply/return duct are not sealed at several points in furnace plenum area
Setback requirement exceptions: residences, hotel/motel guest rooms, areas that operate continuously			AJ 4/15/01
Heat-pump thermostat used with heat pumps	5/20/01	AJ	
Air economizer on systems ≥90,000 Btu/h	NA	NA	Above sealing OK
Exceptions: exempted climate zones, residences, supermarkets, hotel/motel guest rooms, high-efficiency cooling equipment tradeoff minimum EER: 9.9 EER: 10.0	5/20/01	AJ	AJ 4/17/01
8 **Outdoor-Air Ventilation**			½ in. duct liner insulation does not meet R-5 requirement; add insulation
Outdoor air provided to each space (choose one method)			
(a) air intake on mechanical system or	4/15/01	AJ	
(b) operable openings to outdoor air NA sq ft	NA	NA	
Shutoff dampers in restaurant make-up air systems	5/20/01	AJ	AJ 4/20/01
9 **Duct Construction**			
Duct insulation meets minimum R-values			
Ducts in unconditioned spaces R-value R-5 (see note)	4/23/01	AJ	
Ducts outside the building R-value NA	NA	NA	
Ducts sealed			
Transverse joints on metal ducts are sealed	4/17/01	AJ	
All other ducts mechanically or otherwise sealed (no duct tape as primary sealant)	4/15/01	AJ	
10 **Hydronic Heating Systems**			
Pipe insulation: ½ in. on heating coil branches			
1½ in. on circulation loops			
Part-load efficiency method (temp reset / variable flow) (*circle one*)			
11 **Water-Heating Systems**			
Heat traps in inlet/outlet fittings	4/15/01	AJ	
Pipe insulation on inlet/outlet pipes 1 in. thickness	5/20/01	AJ	
Recirculating System (Y / (N)) *(circle one)*			
Pipes insulated NA in. thickness	NA	NA	
Automatic time-switch control	NA	NA	

Section 4 - Compliance Statement

The proposed mechanical design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical system has been designed to meet the 2000 IECC mechanical requirements using COMcheck-EZ™ *Version 2.1.*

12

Principal Mechanical Designer - Name	Signature	Date
William A. Brown, PE	William A. Brown, PE	2/5/00

NOTE: *This form is required on project plans.*

Section 1 - Project Information

1 **Project Name** - name used to identify the project. ? Contact owner/agent.

2 **Address** - project site address. ? Contact owner/agent.

3 **Owner/Agent** - overall project representative; may be owner, project manager, or design professional of record. ? Contact owner/agent.

4 **Documentation Author** - individual responsible for filling out this certificate. ? Contact owner/agent.

EZ Tips

- The design professional of record, if required, should stamp and sign plans, specifications, and subsequent revisions.

Section 2- General Information

5 **Building Floor Area** - total of all heated/cooled gross floor areas measured to outer wall surfaces; include lofts and mezzanines. ? Contact owner/agent.

6 **Project Description** - additions—add new mechanical systems or equipment; alterations—change existing mechanical systems or equipment. ? See pages 3-6, 9-20.

EZ Tips

- Permits for mechanical space-heating or cooling systems cannot be issued to convert unconditioned spaces to conditioned spaces without requiring that the building envelope comply with current requirements for conditioned spaces.

Section 3 - Requirements Checklist

7 **Heating and Cooling System Controls**

Solid-state setback thermostat - show thermostat location in each zone on the plans. ? See pages 3, 11.

Heat pump thermostat - indicate on the plans that thermostats controlling heat pumps are approved for that use. ? See pages 3, 12.

Economizers - determine if required; indicate economizer location and controls on plans; note and justify if 90,000 Btu per hour or any other exceptions exist. ? See pages 4-5, 13-14.

Economizer/EER tradeoff - determine applicability to climate zone and use table to determine tradeoff. ? See page 5; Economizer Tradeoff Table.

EER - cooling system EER must meet or exceed requirements; provide manufacturer cut sheets with system specifications. ? See pages 4-5.

EZ Tips

- The Documentation Author reconciles listed requirements with plan and specification details; determines need for economizer(s) and provides manufacturer cut sheets for thermostats and high-efficiency cooling equipment used to claim economizer/EER tradeoffs.
- The Plan Checker checks the plans to verify that each zone has a separate mechanical system and thermostat. Economizer controls are normally a factory-installed option; verifies that the equipment specified includes these controls.
- The Field Inspector verifies that economizers, dampers, and thermostats are consistent with plans.

8 **Outdoor-Air Ventilation**

Outdoor air to each space - two possible methods of compliance are natural or mechanical ventilation. Plan details should show how all spaces within the building meet provisions (a) and/or (b) for outside air.

? See pages 5-6.

(a) **Air intake on mechanical system** - provide air handler capacity (cubic feet per minute [CFM]) and an air (duct) distribution system, including dampers. Where not prohibited by health and safety codes, outdoor-air supply and exhaust systems with flow rates over 3000 CFM are required to have automatic dampers.

? See pages 5-6.

(b) **Operable openings to outdoor air** - specify ventilation openings on plans for easy determination; include calculations to verify adequate opening areas.

? See page 6.

EZ Tips

- The Documentation Author determines whether natural or mechanical ventilation has been specified; reconciles design values with requirements and plan and specification details; provides system engineering and documentation as required.
- The Plan Checker checks details and calculations for required minimum openings for natural ventilation or required mechanical air supply; as necessary, requires that the documentation author provide adequate mechanical system engineering details and documentation.
- The Field Inspector checks to verify natural ventilation opening areas and/or mechanical ventilation provisions to each space against approved plans and, when needed, air supply dampers with those on the approved plans and specifications (rough mechanical, final); checks dampers for proper connection.

9 **Duct Construction**

Duct insulation meets minimum R-values - material labeling and manufacturer cut sheets as required to document compliance.

? See page 7.

(a) **Ducts in unconditioned spaces** - insulation should not be compressed; plan details should label all unconditioned spaces; supply, return, and exhaust duct types; and those requiring insulation; list R-value per location.

? See pages 7-8.

(b) **Ducts outside the building** - plan details should designate all ducts outside the building and required insulation; list R-value per location.

? See page 7.

Ducts sealed: transverse and longitudinal joints - listed brush-on mastic seals are adequate sealing materials.

? See pages 7-8.

EZ Tips

- Duct liner insulation and/or external insulation should be checked for adequate R-value.
- The Documentation Author determines if duct construction and insulation requirements have been clearly specified on plans and specifications.
- The Plan Checker checks plans and specifications to verify that all duct systems have adequate supply, return, and exhaust type identification symbols and meet location-specific insulation requirements; confirms the need to see duct sealing before external insulation is applied.
- The Field Inspector verifies that ducts have been sealed prior to installation of external duct insulation (rough mechanical) and during subsequent inspection(s); checks insulation R-values and compression and verifies material labeling (duct insulation). Provisions are checked against those on the approved plans and specifications. Look for UL 181A and UL 181B listed duct-sealing systems. Duct tape is not allowed for sealing of metal ducts.

10 Hydronic Heating Systems

Pipe insulation - plan details should indicate ½ -in. insulation on branches for individual heating coils and 1½ in. on all other circulation pipes.

? See page 20.

Part-load efficiency method if greater than 600,000 Btu per hour - at least one of the following methods must be used to increase part-load efficiency. Circle the method used in your design:

? See page 15-16.

temp reset - water temperature reset—automatically resets supply water temperature as a function of load

variable flow - controls to reduce the flow of water as a function of load; valve—variable fluid flow control valve; variable frequency drive (VFD)—varies the speed of the pump; multiple, staged pumps—varies the number of pumps used to circulate water.

EZ Tips

- Heating-only hydronic systems can be used for buildings that are not air conditioned.
- Each zone must have a thermostat that meets the heating system control requirements above.
- The Documentation Author indicates on the plans the location of zone thermostats, the thickness of pipe insulation, and the control method if the capacity exceeds 600,000 Btu per hour and provides manufacturer cut sheets.
- The Plan Checker verifies that the pipe insulation thickness is indicated on the plans; if capacity exceeds 600,000 Btu per hour, verifies that efficiency control method is indicated on the plans.
- The Field Inspector verifies that pipe insulation thickness, thermostat types and locations, and efficiency controls are consistent with the plans.

11 Water-Heating Systems

Heat traps in inlet / outlet fittings - plan details should indicate all heat trap locations where water heaters do not have integral heat traps.

? See page 23.

Pipe insulation on service and domestic water heater inlet / outlet pipes - plan details should indicate insulation thickness.

? See page 23.

Recirculating system piping insulation and loop controls - if present, plan details should indicate insulation and loop controls.

? See page 23.

Swimming pool On / Off switch control and pool cover - if present, plan details should indicate cover and control.

? See page 24.

EZ Tips

- Subcontractors are often not on the job when inspections occur, so providing complete information on plans ensures compliance.
- The Documentation Author, where applicable, shows water heater heat trap details or verifies from manufacturer that heaters have integral traps; normal and circulating piping insulation; automatic controls; and swimming pool shutoffs, controls, and pool covers; reconciles with plans and specifications.
- The Plan Checker confirms the presence of adequate piping details in the plans and specifications to address each type of insulation, heat trap, and control requirement.
- The Field Inspector verifies that all heat traps, piping insulation, and time-switch controls for circulation piping are consistent with the plans and specifications (rough mechanical, final); verifies that water heaters have integral or field-applied heat traps.

Section 4 – Compliance Statement

12 Principal Mechanical Designer - Name - If required by the code official, the documentation author or design professional of record must print his / her name, sign, and date the certificate in the boxes provided to acknowledge that the structure has been designed to meet the 2000 IECC Simple Systems mechanical requirements using COM*check-EZ* Version 2.1.

EZ Tips for Mechanical Enforcement

Plan Check

- Permits for mechanical space-heating or cooling systems cannot be issued to convert unconditioned space to conditioned space without requiring that the building envelope comply with the current requirements for conditioned spaces.
- Verify that each zone has a separate mechanical system controlled by a programmable thermostat with occupant override unless an exception exists. Because economizer controls are normally a factory-installed option, verify that either the equipment specified includes these controls or that their field installation is indicated on the plans.
- Check details and calculations to verify that the required minimum openings for natural ventilation or required mechanical air supply are provided on the plans.
- Verify that all duct systems have adequate supply, return, and exhaust type identification symbols and meet location-specific insulation requirements; confirm the need to inspect duct sealing before external insulation is applied.
- Check hydronic system plans to verify that the plans indicate the system is for heating only; the location and required type of thermostats; the required pipe insulation thickness; and the part-load control method if the capacity exceeds 600,000 Btu per hour.
- Verify that details are adequate for water heater heat traps (either integral or field installed) and that plans indicate required insulation thickness on inlet/outlet pipes, insulation thickness on pipes and timer control for recirculating systems, and a pool cover and both On/Off and time-switches for swimming pools.

Field Inspection

- Verify that economizers, dampers, and thermostats are consistent with plans.
- Verify that the natural ventilation opening areas and/or mechanical ventilation provisions to each space are consistent with the plans and that all dampers are properly connected.
- Verify that ducts have been sealed prior to installation of external duct insulation; check insulation for compression and verify that R-values are consistent with the plans. Look for UL 181A and UL 181B identification on duct-sealing materials. Traditional duct tape (gray, black, or foil) is not approved for duct sealing.
- Inspect hydronic systems for pipe insulation thickness, thermostat types and locations, and efficiency controls to verify that they are consistent with the plans.
- Verify that all heat traps, piping insulation, and time-switch controls for recirculating water piping are consistent with the plans and that water heaters have integral or field-installed heat traps.

Simple Mechanical Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

Project Name		Permit #
Address		Date
Owner/Agent	Telephone	Checked By
Documentation Author	Telephone	Date For Department Use Only

Section 2 - General Information

Building Floor Area _____

Project Description ☐ New Construction ☐ Addition ☐ Alteration ☐ Unconditioned Shell

Section 3 - Requirements Checklist

Heating and Cooling System Controls	**Inspection Date**	**Approved By**	**Notes**
One solid-state setback thermostat with occupant override per zone			
Setback requirement exceptions: residences			
hotel/motel guest rooms			
areas that operate continuously			
Heat-pump thermostat used with heat pumps			
Air economizer on systems ≥90,000 Btu/h			
Exceptions: exempted climate zones			
residences, supermarkets, hotel/motel guest rooms, high-efficiency cooling equipment tradeoff			
minimum EER: _____ EER: _____			
Outdoor-Air Ventilation			
Outdoor air provided to each space (choose one method)			
(a) air intake on mechanical system or			
(b) operable openings to outdoor air ___ sq ft			
Shutoff dampers in restaurant make-up air systems			
Duct Construction			
Duct insulation meets minimum R-values			
Ducts in unconditioned spaces R-value _____			
Ducts outside the building R-value ____			
Ducts sealed			
Transverse joints on metal ducts are sealed			
All other ducts mechanically or otherwise sealed (no duct tape as primary sealant)			
Hydronic Heating Systems			
Pipe insulation: ½ in. on heating coil branches			
1½ in. on circulation loops			
Part-load efficiency method (temp reset / variable flow) (*circle one*)			
Water-Heating Systems			
Heat traps in inlet/outlet fittings			
Pipe insulation on inlet/outlet pipes ___ in. thickness			
Recirculating System (Y / N) *(circle one)*			
Pipes insulated ____ in. thickness			
Automatic time-switch control			

Section 4 - Compliance Statement

The proposed mechanical design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical system has been designed to meet the 2000 IECC mechanical requirements using COM*check-EZ™ Version 2.1.*

Principal Mechanical Designer - Name	**Signature**	**Date**

NOTE: *This form is required on project plans.*

Completing Mechanical Compliance Certificate for Complex Systems

The process for filling in the mechanical compliance certificate for complex systems is very similar to that for simple systems. Because they are so similar, neither a sample certificate nor step-by-step instructions are provided for the complex systems certificate. See the sample mechanical certificate for simple systems and instruction beginning on page 25 for guidance in completing the mechanical compliance certificate for complex systems.

Mechanical Compliance Certificate for Complex Systems for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

Project Name		Permit #
Address		Date
Owner/Agent	Telephone	Checked By
Documentation Author	Telephone	Date For Department Use Only

Section 2 - General Information

Building Floor Area _____ sf

Project Description ☐ New Construction ☐ Addition ☐ Alteration ☐ Unconditioned Shell

Section 3 - Requirements Checklist

	Inspection Date	Approved By	Notes
Load Calculations			
• Load calculations per 1997 ASHRAE Fundamentals and • Capacities shown on plans	_____	_____	
Equipment Efficiency			
• Newly purchased equipment covered by mfr. Std. or ☐ • Meets efficiency requirements in table ☐	_____	_____	
HVAC System Controls			
• Minimum one temperature control device per zone	_____	_____	
• Minimum thermostat capabilities: - Minimum 5° F deadband - Setback/setup capability to 55°F (htg.) & 85°F (clg.) - 7-day clock, 2-hr occupant override, 10-hr backup Thermostat setback capability exceptions: multifamily residential ☐ hotel/motel guest rooms ☐ areas that operate continuously ☐	_____	_____	
• Heat pump thermostat used with supplemental electric resistance heat	_____	_____	
Outdoor-Air Ventilation			
• In accordance with Chapter 4 of the IMC	_____	_____	
• Automatic shut-off dampers on supply and exhaust systems with airflow >3,000 cfm	_____	_____	
Economizers			
• Economizers on systems ≥90,000 Btu/h or ≥3,000 cfm Exceptions: exempted climate zone ☐ supermarkets, residential, hotel guest rooms ☐ high-efficiency cooling equipment tradeoff ☐ minimum EER: _____ EER: _____ other _____ ☐	_____	_____	
Hydronic Systems Control			
• Separate hot and cold water supplies and returns	_____	_____	
• No capability for concurrent hot and chilled water supply to terminals Exception: zones with special humidity requirements ☐	_____	_____	
• Hydronic systems $ 600 kBtu/h have: - reset controls for supply water temperature or ☐ - mechanical or electrical adjustable-speed pump drive(s) or ☐ - multiple-stage pumps or ☐ - other system controls that reduce pump flow by at least 50% based on load (calculations required) ☐			

Mechanical Compliance Certificate for Complex Systems(Continued)

Section 3 - Requirements Checklist

	Inspection Date	Approved By	Notes
Variable Air Volume Fan Control			
• Systems serving more than one zone are VAV Exceptions: - special pressurization relationships ☐ - 75% energy recovery ☐ - special humidity requirements ☐ - zone supply <300 cfm & <10% of total fan supply ☐ - where reheated/recooled air < min OSA req. ☐ - sequential controls that prevent reheat/recool ☐			
• VAV fans with motors $ 25 hp: - have mech. or elec. variable speed drive(s) or ☐ - are vane-axial fans with variable pitch blades or ☐ - have other controls that reduce motor demand to 50% design kW at 50% design flow (calcs. req.) ☐			
• Controls are capable of resetting supply air temp (SAT) by 25% of (SAT - room temp) difference			
• Single-duct VAV terminals are capable of reducing primary air before reheating			
• Dual-duct VAV mixing boxes are installed to minimize mixing			
Duct Construction			
• Duct insulation meets minimum R-values - Ducts in unconditioned spaces R-value _____ - Ducts outside the building R-value _____			
• Ducts sealed - Joints and seams on ductwork fastened and sealed per UL 181A or B (no duct tape as primary sealant)			
- Systems with $3" wg sealed in accordance with SMACNA Leakage Class (CL) < 6.0			
Hydronic Heating Systems			
• Pipe insulation: - ½ in. orheating coil branches - 1½ in. orcirculation loops			
• Part-load efficiency method: - temperature reset or ☐ - variable flow ☐			
HVAC System Completion			
• Balancing devices in accordance with IMC 603.15			
• Balancing and pressure test connections on all hydronic terminal devices			
• O & M manual(s) provided to building owner			

Section 4 - Compliance Statement

The proposed mechanical design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical system has been designed to meet the 2000 IECC mechanical requirements using COM*check-EZ™ Version 2.1.*

Principal Mechanical Designer – Name	Signature	Date

NOTE: *This form is required on project plans.*

TABLE 803.2.2(1) [2000 IECC]
UNITARY AIR CONDITIONERS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]	Mfr. Std.[d]	Test Procedure[a]
Air Conditioners, Air Cooled	< 65,000 Btu/h	Split System	10.0 SEER	✓	ARI 210/240
		Single Package	9.7 SEER		
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	8.9 EER[c] 8.3 IPLV[c]	✓	ARI 210/240
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	8.5 EER[c] 7.5 IPLV[c]	✓	ARI-340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split System and Single Package	8.5 EER[c] 7.5 IPLV[c]		ARI-340/360
	≥ 760,000 Btu/h	Split System and Single Package	8.2 EER[c] 7.5 IPLV[c]		ARI-340/360
Air Conditioners, Evaporatively Cooled	< 65,000 Btu/h	Split System and Single Package	9.3 EER 8.5 IPLV	✓	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.5 EER[c] 9.7 IPLV[c]	✓	ARI 210/240
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	9.6 EER[c] 9.0 IPLV[c]	✓	ARI-340/360
	≥ 240,000 Btu/h	Split System and Single Package	9.6 EER[c] 9.0 IPLV[c]		ARI-340/360
Air Conditioners, Water Cooled	< 65,000 Btu/h		9.3 EER 8.3 IPLV	✓	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h		10.5 EER[c]	✓	ARI 210/240
	≥ 135,000 Btu/h and < 240,000 Btu/h		9.6 EER[c] 9.0 IPLV[c]	✓	ARI-340/360
	≥ 240,000 Btu/h		9.6 EER[c] 9.0 IPLV[c]		ARI-340/360

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the 1992 Energy Policy Act have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)
[c] For units that have a heating section, deduct 0.2 from al required EERs and IPLVs.
[d] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.2.2(2) [2000 IECC]
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]	Mfr. Std.[c]	Test Procedure[a]
Heat Pumps, Air Cooled (Cooling Mode)	< 65,000 Btu/h	Split System	10.0 SEER	✓	ARI 210/240
		Single Package	9.7 SEER	✓	
	$ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	8.9 EER 8.3 IPLV	✓	ARI 210/240
	$ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV	✓	ARI-340/360
	$ 240,000 Btu/h and < 760,000 Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV		ARI-340/360
	$ 760,000 Btu/h	Split System and Single Package	8.2 EER 7.5 IPLV		ARI-340/360
Heat Pumps, Evaporatively Cooled, (Cooling Mode)	< 65,000 Btu/h	Split System and Single Package	9.3 EER 8.5 IPLV	✓	ARI 210/240
	$ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.5 EER 9.7 IPLV	✓	ARI 210/240
Heat Pumps, Water Cooled, Water-Source (Cooling Mode)	< 65,000 Btu/h	85 EF Entering Water 75 EF Entering Water	9.3 EER 10.2 EER	✓	ARI-320
	$ 65,000 Btu/h and < 135,000 Btu/h	85 EF Entering Water	10.5 EER	✓	ARI-320
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	70EF Entering Water 50EF Entering Water	11.0 EER 11.5 EER		ARI 325
Heat Pumps, Air Cooled (Heating Mode)	< 65,000 Btu/h (Cooling Capacity)	Split System	6.8 HSPF	✓	ARI 210/240
		Single Package	6.6 HSPF	✓	
	$ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47EF db/43EF wb Outdoor Air 17EF db/15EF wb Outdoor Air	3.0 COP 2.0 COP	✓	ARI 210/240
	$ 135,000 Btu/h and < 240,000 Btu/h (Cooling Capacity)	47EF db/43EF wb Outdoor Air 17EF db/15EF wb Outdoor Air	2.9 COP 2.0 COP	✓	ARI-340/360
	$ 240,000 Btu/h (Cooling Capacity)	47EF db/43EF wb Outdoor Air 17EF db/15EF wb Outdoor	2.9 COP 2.0 COP		ARI-340/360
Heat Pumps, Water-Cooled, Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	70EF Entering Water	3.8 COP	✓	ARI-320
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	70EF Entering Water 50EF Entering Water	3.4 COP 3.0 COP		ARI 325

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the 1992 Energy Policy Act have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)
[c] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.2.2(3) [2000 IECC]
PACKAGED TERMINAL AIR CONDITIONERS, PACKAGED TERMINAL HEAT PUMPS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]	Mfr. Std.[d]	Test Procedure[a]
PTAC and PTHP (Cooling Mode)	All Capacities	95EF db Outdoor Air	10.0 - (0.16 x Cap/1,000)[c] EER	✓	ARI 310/380
		82EF db Outdoor Air	12.2 - (0.20 x Cap/1,000)[c] EER	✓	
PTHP (Heating Mode)	All Capacities		2.90 - (0.026 x CAP/1,000)[c] COP	✓	

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the 1992 Energy Policy Act have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)
[c] Cap means the rated capacity of the product in Btu/h. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.
[d] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.2.2(4) [2000 IECC]
WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, HEATERS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b,e]	Mfr. Std.[f]	Test Procedure[a]
Warm Air-Furnace, Gas-Fired	< 225,000 Btu/h		78% AFUE or 80% E_t[d]	✓	DOE 10 CFR 430 Subpart B, Appendix E
	$ 225,000 Btu/h	Maximum Capacity[c]	80% E_t[f]	✓	ANSI Z21.47
Warm Air-Furnace, Oil-Fired	< 225,000 Btu/h		78% AFUE or 80% E_t[d]	✓	DOE 10 CFR 430 Subpart B, Appendix E
	$ 225,000 But/h	Maximum Capacity[c]	81% E_t[f]	✓	U.L. 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[c] Minimum Capacity	78% E_t 75% E_t		ANSI Z83.9
Warm Air Unit Heaters, Gas Fired	All Capacities	Maximum Capacity[c] Minimum Capacity	78% E_t 74% E_t		ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[c] Minimum Capacity	81% E_t 81% E_t		U.L. 731

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated at different rating conditions.
[c] Minimum and maximum ratings as provided for and allowed by the unit's controls.
[d] Combination units not covered by NAECA (Three-phase power or cooling capacity $ 65,000 Btu/h) may comply with either rating.
[e] E_t = thermal efficiency. See referenced document for detailed discussion.
[f] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.2.2(5) [2000 IECC]
BOILERS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b,d]	Mfr. Std.[e]	Test Procedure[a]
Boilers, Gas-Fired	< 300,000 Btu/h	Hot Water	80% AFUE	✓	DOE 10 CFR 430; Part 430; Subpart B, App. N
		Steam	75% AFUE	✓	DOE 10 CFR 430; Part 430; Subpart B, App. N
	$ 300,000 Btu/h	Maximum Capacity[c] Minimum Capacity	80% E_c 80% E_c	✓	HI HBS 86 or ANSI Z21.13
Boilers, Oil-Fired	< 300,000 Btu/h		80% AFUE	✓	DOE 10 CFR 430; Part 430; Subpart B, App. N
	$ 300,000 Btu/h	Maximum Capacity[c] Minimum Capacity	83% E_c 83% E_c	✓	HI HBS 86
Oil-Fired (Residual)	$ 300,000 Btu/h	Maximum Capacity[c] Minimum Capacity	83% E_c 83% E_c	✓	HI HBS 86

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated.
[c] Minimum and maximum ratings as provided for and allowed by the unit's controls.
[d] E_c = combustion efficiency (100% less flue losses). See reference document for detailed information.
[e] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.3.2(1) [2000 IECC]
CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]	Mfr. Std.[c]	Test Procedure[a]
Condensing Units, Air Cooled	≥ 135,000 Btu/h		9.9 EER 11.0 IPLV		ARI 365
Condensing Units, Water or Evaporatively Cooled	≥ 135,000 Btu/h		12.9 EER 12.9 IPLV		

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] IPLVs are only applicable to equipment with capacity modulation.
[c] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard. New equipment can be assumed to meet the requirements of this code.

TABLE 803.3.2(2) [2000 IECC]
WATER CHILLING PACKAGES, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]	Mfr. Std.[d]	Test Procedure[a]
Air-Cooled Chiller, with Condenser,	< 150 Tons		2.7 COP 2.8 IPLV		ARI 550 or 590
	≥ 150 Tons		2.5 COP 2.5 IPLV		
Air-Cooled Chiller, without Condenser,	All Capacities		3.1 COP 3.2 IPLV		
Water Cooled Chiller	< 150 Tons		3.8 COP 3.9 IPLV		
	≥ 150 Tons and < 300 Tons		4.2 COP 4.5 IPLV		
	≥ 300 Tons		5.2 COP[c] 5.3 IPLV[c]		

[a] See Chapter 9 of the 2000 IECC for detailed references.
[b] Equipment must comply with all efficiencies when multiple efficiencies are indicated.
[c] These requirements are reduced to 4.7 COP and 4.8 IPLV, where R-22 is used or where refrigerants with ozone depletion factors less than or equal to that for R-22 are used.
[d] Check mark (✓) and shading indicate equipment in the category is covered by a minimum-efficiency manufacturing standard (Water Chilling Packages are not covered by minimum-efficiency manufacturing standard.)

Lighting Compliance

Lighting Requirements

You can use COM*check-EZ*™ to demonstrate that your commercial or high-rise residential building design complies with the 2000 Edition of the IECC.

This guide covers the energy code requirements for lighting systems and equipment. It includes necessary tables, worksheets, and instructions for demonstrating compliance using an entirely manual method. All you need is a pencil and copies of the *Lighting Compliance Certificate* and *Lighting Application Worksheet* at the end of this guide.

The COM*check-EZ* software provides an alternative compliance method to using this guide. The compliance calculation used in the software is identical to the manual version in this guide. The software simply automates the calculation of the lighting power allowance for the building and the connected load of the lighting systems you specify. It also generates a compliance report to submit with your building permit application. Refer to the COM*check-EZ Software Compliance Guide* for instructions on obtaining and using the software.

What the Energy Code Covers

To promote the use of energy-efficient lighting in commercial and high-rise residential buildings, the energy code requires

- manual or automatic controls or switches that allow occupants to dim lights and turn them on or off when appropriate. This guide identifies control, switching, and wiring requirements that apply to all buildings.
- total connected loads for indoor lighting systems that do not exceed power allowances for the building. This guide shows how to demonstrate compliance with interior-lighting power limits using the *Lighting Application Worksheet*.
- energy-efficient exterior lighting. This guide contains criteria for complying with exterior-lighting requirements.

Demonstrating Compliance

To demonstrate compliance,

- indicate on your project plans switching schemes, fixture types, and lamp/ballast types that comply.

- complete the *Lighting Application Worksheet* included with this guide to indicate compliance with indoor-lighting power limits.
- complete the *Lighting Compliance Certificate* included with this guide. Use the actual fixture wattages or, if actual fixture wattages are unavailable, typical wattages from the *Typical Lighting Wattage* table at the end of this guide.

Control, Switching, and Wiring Requirements

All lighting systems must have controls or switches that allow occupants to manually or automatically dim lights or turn them on or off.

Interior-Lighting Controls

Independent interior-lighting controls are required for each area enclosed by ceiling-height partitions. These controls can be any of the following:

- a switch located so the occupant can see the area controlled by the switch
- a switch that indicates whether the lights are on or off when it is impossible to see the controlled area from the switch location
- an occupant-sensing device.

Exceptions to this requirement are

- areas that must be continuously illuminated for building security or emergency exits. These areas must be designated as security or emergency exit areas on the plans, and the lights must be controlled by switches accessible only to authorized personnel.
- public areas, such as building lobbies and retail stores. These lights can be controlled by a single switch for the entire area.

Master Switches in Hotel and Motel Guest Rooms

One or more master light switches are required at the entry door of hotel and motel guest rooms. Master switches operate all permanently wired luminaires and switched receptacles. These switches are usually three-way devices wired in combination with local controls. In multiple-room suites, a standard control device is required at the entrance to each separate room.

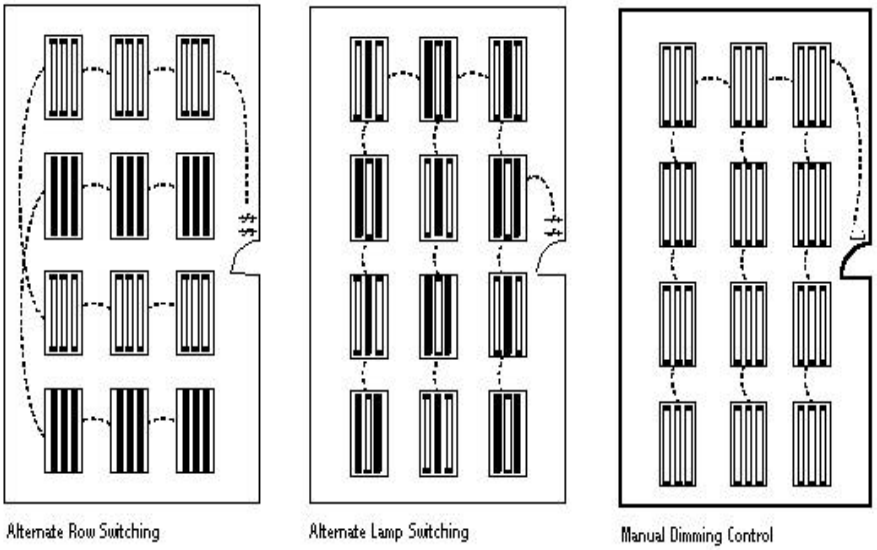
Bathroom lighting systems in hotel and motel guest rooms are exempt from these requirements.

Bi-Level Switching

Lighting within a space must be switched so the occupant can reduce the connected lighting load by at least 50% in a reasonably uniform illumination pattern. Bi-level switching requirements may be met by

- switching alternate luminaires in a row or alternate rows of luminaires
- separately switching half of the lamps in each luminaire or two lamps in three-lamp luminaires

- using dimming controls on all lamps or luminaires.



Bi-level switching is not required if

- the area has only one luminaire
- an occupant-sensing device controls the area
- the area is a corridor, storage area, restroom, or lobby.

Exterior Lighting Controls

Automatic controls are required for all exterior lights. The control may be a directional photocell, an astronomical time switch, or a building automation system with astronomical time switch capabilities. The control must automatically turn off exterior lighting when daylight is available. Lights in parking garages, tunnels, and other large-covered areas that must be on during daylight hours are exempt from this requirement.

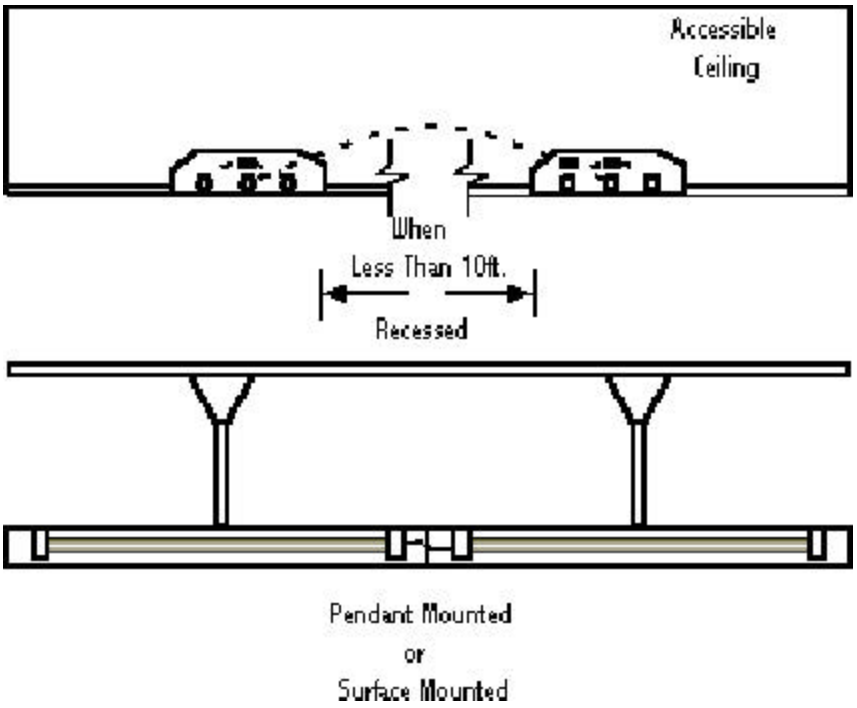
Tandem Wiring

A two-lamp ballast is the most efficient conventional ballast type. The following types of one-lamp or three-lamp fluorescent fixtures must be tandem-wired:

- pendant- or surface-mounted luminaires in continuous rows
- recess-mounted luminaires located within 10 ft of each other and served by the same switch.

Exempted from this requirement are

- luminaires that use electronic high-frequency ballasts
- luminaires that are not on the same switch control or in the same area.



Tandem Wiring

Interior Lighting Requirements

Interior lighting must not exceed allowed power limits. Interior lighting includes all permanently installed general and task lighting shown on the plans.

To determine if your project complies with the interior-lighting power limits, follow the steps outlined below using the *Lighting Application Worksheet* included with this guide.

Determining Allowed Watts for an Entire Building

First, if your project applies to the entire building, determine if an appropriate building type category is listed in Section 1, Column A on the Lighting Application Worksheet. Next, determine if Column B assigns a value for the entire building. If so, enter the square footage of the entire building in Column D. (If the value in Column B is N/A, follow the steps for tenant area or portion of building in the following section.) Multiply the watts per sq ft in Column B by the square footage in Column D to determine the allowed watts. Enter the results in Column E.

This example shows how to calculate the total allowed watts for new general office space occupying an entire building totaling 10,000 sq ft. This building has a 1.3 watt sq ft allowance. The total allowed watts value for the building is determined by multiplying Column B by Column D (13,000 watts).				
Section 1 – Allowed Lighting Power Calculation				
A	B	C	D	E
Building or Area Type	Entire Building (watts per sq ft)	Tenant Area or Portion of Building (watts per sq ft)	Building or Space (sq ft)	Allowed Watts** (B or C x D)

Office	1.3	1.5	10,000	13,000
			Total Allowed Watts	13,000
**May use only Column B or Column C to qualify project. Do not use more than one column.				

Example - Determining Allowed Watts for an Entire Building

This example shows how to calculate the total allowed watts for new general office space occupying tenant area totaling 10,000 sq ft. The watts per sq ft allowance for this building is a combination of general office and corridor, restroom, and support areas. The total allowed watts value for the building is determined by multiplying the watts per sq ft for each area in Column C by the square footage of each area in Column D. The total allowed watts value is determined by adding the values in Column E (14,300 watts).

Section 1 – Allowed Lighting Power Calculation

A	B	C	D	E
Building or Area Type	Entire Building (watts per sq ft)	Tenant Area or Portion of Building (watts per sq ft)	Building or Space (sq ft)	Allowed Watts** (B or C x D)
Corridor, Restroom, Support Area	N/A	0.8	1,000	800
Office	1.3	1.5	9,000	13,500
			Total Allowed Watts	14,300
**May use only Column B or Column C to qualify project. Do not use more than one column.				

Example - Determining Allowed Watts for Tenant Area or Portion of Building

Determining Allowed Watts for Tenant Area or Portion of Building

If your project applies to only a portion of the entire building, is not listed as a building type, or has more than one occupancy type, circle the appropriate value for each type in Section 1, Column C on the *Lighting Application Worksheet*. Next, determine the total area of each type and enter the square footage for each in Column D. Multiply the watts per sq ft in Column C by the square footage in Column D. Enter the results in Column E. Sum the values in Column E to determine the total allowed watts.

Determining Total Actual Watts and Compliance

Next, complete Section 2 on the *Lighting Application Worksheet* to determine the total actual watts. For each fixture type in your project, list the fixture type, fixture description, quantity, and watts per fixture, including ballasts.

- For screw lamp holders, use the maximum labeled wattage of the luminaire.
- For low-voltage lighting, use the specified wattage of the transformer supplying the system.
- For all other lighting equipment, use data furnished by the manufacturer.
- For line-voltage track lighting systems, use the larger of the results from the three bullets above or 30 watts per linear foot of track.

If actual input wattages are not known, you may use values from the *Typical Lighting Wattage* tables at the end of this section; however, actual fixtures used in the building must meet or exceed the efficiency of the fixtures assumed in the compliance analysis.

Multiply the value in Column D by the value in Column E to calculate the total watts for each fixture type. Enter the results in Column F. Sum the values in Column F to determine the total actual watts. If you need to list more equipment, use additional worksheets as continuation sheets.

Finally, determine if your project complies by completing Section 3 on the *Lighting Application Worksheet*. First, enter the total allowed watts on line 1. If you used additional worksheets as continuation sheets, don't forget to include values from each additional sheet in this total. Next, enter the total actual watts on line 2. Subtract line 1 from line 2 to determine compliance. The project complies if line 3 is zero or greater.

This example shows how to complete Sections 2 and 3 of the *Lighting Application Worksheet*. The interior of this example building is lit with two high-efficiency lighting groups–recessed compact fluorescent (CFL) downlights and 2x4 fixtures with electronic ballasts and T-8 lamps. This system also includes standard incandescent lamps. Adding the values in Column F shows that this project will have 13,635 total actual watts of installed interior lighting.

Section 2 – Actual Lighting Power Calculation

A	B	C	D	E	F
Fixture ID	Fixture Description	Lamp/Ballast	Quantity	Watts per Fixture	D x E
F1	2x4 Recessed Troffer	T8/Electronic	85	121	10,285
F2	Recessed CFL Fixture	CFL 18	50	22	1,100
F3	Medium-Base Socket	100 W	30	75	2,250
				Total Actual Watts	13,635

The value resulting from subtracting the total actual watts from the total allowed watts indicates if the project complies. Our example project complies by 665 watts and, if properly switched, controlled, and wired, complies with the lighting requirements.

Section 3 – Compliance Calculation

1	Total Allowed Watts	14,300
2	Total Actual Watts	13,635
3	Project Compliance (line 1 – line 2; must be zero or greater)	665

Example - Determining Total Actual Watts and Lighting Compliance

Exterior Lighting Requirements

Exterior lighting must meet the following criteria to comply:

- All lighting supplied through the building electrical service must comply.
- Energy-efficient lighting must be used when illuminating paths, walkways, and parking areas. Complying types of energy-efficient lighting sources include fluorescent lamps and ballasts, compact fluorescents, metal halide lamps and ballasts, and high-pressure sodium lamps and ballasts.
- Any lighting that has an efficacy of 45 lumens per watt or greater is allowed for exterior lighting.

These requirements do not apply to

- specialized signal, directional, and marker lighting associated with air, rail, water, and road transportation

- lighting used to highlight features of registered historic landmark structures or buildings
- lighting used for safety or security specifically designed to meet health or life safety requirements
- low-voltage lighting used exclusively for landscaping.

Completing Lighting Compliance Certificate

These instructions explain the information to include in the COM*check-EZ* Lighting Compliance Certificate, identify the appropriate contact or reference if you have questions, provide *EZ* tips for completing the certificate, and provide instructions for completing the Lighting Power Calculation. A sample certificate and worksheet are also provided. The instructions have numbered circles that correspond to those on the sample certificate and worksheet. For code enforcement officials, *EZ* tips for plan check and field inspection are included at the end of this guide.

General Guidance

For Documentation Authors: Provide all information in unshaded sections, entering "N/A" if a particular requirement is not applicable; submit the completed certificate to the authority having jurisdiction with the building permit application package.

For Plan Checkers: Verify that proposed values listed on the certificate are consistent with the plans and specifications and with the requirements in this guide.

For Field Inspectors: Inspect and approve building construction against each requirement in Section 3 of the certificate.

Typical Lighting Wattage

Typical T8/T12 Fluorescent Input Wattage

Lamp Length	Lamp Quantity	Lamp Description	Lamp Wattage	Energy-Efficient Magnetic Ballast (EEF)	Electronic Ballast (ELC)
2 ft	1	T12U	40	46	36
	2	T12U	40	86	67
	3	T12U	40	130	101
	1	T12U ES	34	41	31
	2	T12U ES	34	72	59
	3	T12U ES	34	109	89
	1	T8U	32	36	35
	2	T8U	32	69	62
	3	T8U	32	105	75
	1	T8	17	24	22
	2	T8	17	45	33
	3	T8	17	---	54
	4	T8	17	---	65
3 ft	1	T8	25	33	27
	2	T8	25	65	48
	3	T8	25	---	72
	4	T8	25	---	93
	1	T12	30	46	---
	2	T12	30	79	---
	3	T12	30	122	---
	1	T12 ES	25	42	26
	2	T12 ES	25	70	53
	3	T12 ES	25	114	---
4 ft	1	T8	32	37	32
	2	T8	32	70	65
	3	T8	32	107	95
	4	T8	32	140	124
	1	T10	42	46	37
	2	T10	42	92	74
	3	T10	42	138	111
	4	T10	42	184	148
	1	T12	40	45	37
	2	T12	40	84	72
	3	T12	40	125	106
	4	T12	40	160	142
	1	T12 ES	32	38	---
	2	T12 ES	32	68	---
	3	T12 ES	32	103	---
	4	T12 ES	32	136	---
	1	T12 ES	34	42	32
	2	T12 ES	34	70	62
	3	T12 ES	34	109	92
	4	T12 ES	34	139	123
	1	T12 Slim	39	51	---
	2	T12 Slim	39	82	---
	1	T12 Slim ES	32	59	---
	2	T12 Slim ES	32	98	---
5 ft	1	T8	40	50	46
	2	T8	40	92	79
	3	T8	40	---	109
8 ft	1	T8	75	79	65
	2	T8	75	158	130
	3	T8	75	237	195
	4	T8	75	316	260
	1	T8 ES	60	62	53
	2	T8 ES	60	123	105
	3	T8 ES	60	185	158
	4	T8 ES	60	246	210
	1	T12 Slim	75	100	---
	2	T12 Slim	75	166	130
	3	T12 Slim	75	---	195
	4	T12 Slim	75	316	260
	1	T12 Slim ES	60	83	---
	2	T12 Slim ES	60	131	105
	4	T12 Slim ES	60	246	210

8 ft	1	T12 HO	110	140	---
	2	T12 HO	110	245	190
	4	T12 HO	110	474	380
	1	T12 HO ES	95	125	---
	2	T12 HO ES	95	217	160
	4	T12 HO ES	95	416	320

---	No typical wattage value available
T12	1½-inch diameter fluorescent lamp
T10	1 ¼-inch diameter fluorescent lamp
T8	1-inch diameter fluorescent lamp
U	"U"-shaped fluorescent lamp
ES	Energy -saving lamp–typically lower wattage than its standard counterpart
Slim	A type of lamp with single end-pins for instant start operation only
HO	A high output lamp having higher input wattage and higher light output than standard lamp of that size

Typical Compact Fluorescent Input Wattage

Lamp Quantity	Lamp Type	Lamp Wattage	Magnetic Ballast (MAG)	Electronic Ballast (ELC)
1	Twin Tube	8/9	13	---
2		8/9	26	---
1		13	17	---
2		13	34	---
1		18	23	17
2		18	46	35
3		18	69	52
4		18	92	70
1		24/26/27	32	21
2		24/26/27	66	43
3		24/26/27	99	64
4		24/26/27	132	86
1		36/39	51	37
2		36/39	66	70
3		36/39	108	106
4		36/39	132	140
1		40	43	36
2		40	86	71
3		40	130	104
4		40	172	142
1		50	---	54
2		50	---	106
3		50	---	139
4		50	---	212
1		55	---	62
1	Triple 4-pin	13	18	---
2		13	36	---
1		18	25	---
2		18	50	---
1		26	37	---
2		26	74	---
1	Quad 2-pin	9	13	---
2		9	26	---
1		13	17	---
2		13	34	---
1		16	20	---
2		16	40	---
1		18	24	---
2		18	47	---
1		22	27	---
2		22	54	---
1		26	32	---
2		26	65	---
1		28	34	---
2		28	68	---
1	Quad 4-pin	10	15	---
2		10	29	---
1		13	17	---
2		13	34	---
1		18	242	---
2		18	47	---

Twin Tube — A lamp consisting of two parallel tubes attached to a base with typically 2 pins.
Triple 4-pin — A lamp consisting of three parallel tubes attached to a base with 4 pins.
Quad 2-pin — A lamp consisting of four parallel tubes attached to a base with 2 pins.
Quad 4-pin — A lamp consisting of four parallel tubes attached to a base with 4 pins.

Typical HID Input Wattage

Lamp Description	Lamp Wattage	Magnetic Ballast (MAG)	Lamp Description	Lamp Wattage	Magnetic Ballast (MAG)
Metal Halide	50	67	High-Pressure Sodium	35	43
	70	95		50	64
	75	85		70	94
	100	130		100	130
	150	210		150	190
	175	210		20	245
	250	295		250	300
	400	465		400	465
	1000	1080		1000	1100
	1500	1625			

Sample Lighting Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

1	Project Name: **The Ultimate Pizza Place**		**Permit #** **M9958**
2	Address: **1234 Jobsite, USA**		**Date** **12/16/00**
3	Owner/Agent: **Cris Doe**	Telephone: **(333) 337-2121**	**Checked By** **B. Jones**
4	Documentation Author: **Jeff A. Jackson, PE**	Telephone: **(333) 333-1234**	**Date** **1/20/01** **For Department Use Only**

Section 2 - General Information

5 Building Floor Area **12,500 ft²**

6 Project Description ☒ New Construction ☐ Addition ☐ Alteration

7 Method of Lighting Compliance ☒ Entire Building ☐ Tenant Area or Portion of Building

Section 3 - Requirements Checklist

8

Controls, Switching, and Wiring	Inspection Date	Approved By	Notes
Independent controls for each space (switch/occupancy sensor) Exceptions: security lighting building lobby/retail store/mall	5/20/01	AJ	1) Only one switch in small banquet room two needed
Master switch at entry to each hotel/motel guest room	NA	NA	
Two switches, dimmer, or occupancy sensor in each space providing a uniform illumination pattern **(see note)** Exceptions: the area has only one luminaire an occupant-sensing device controls the area the area is a corridor, storage area, restroom, or lobby	5/25/01	AJ	2) Replace several four-lamp fixtures in dining area with three-lamp fixtures
Photocell or astronomical time-switch on exterior lights Exception: large covered areas requiring lighting during daylight hours	5/25/01	AJ	
Tandem-wired one-lamp and three-lamp ballasted luminaires **(see note)** Exceptions: electronic high-frequency ballasted luminaires luminaires not on same switch	5/25/01	AJ	3) Wattage exceeded by these units. PK 5/20/01

9

Interior Lighting

Total actual watts must be less than or equal to total allowed watts

10

Allowed Watts	Actual Watts	Lighting Complies (Y/N)
21,595	21,223	Y

(see note)

5/25/01 (2nd Insp) — AJ — Fixtures, lamps and wattage OK. PK 5/25/01

External Lighting

Type(s) of exterior-lighting sources:

☒ fluorescent ☐ metal halide ☐ high-pressure sodium — 5/20/01 — AJ

Lighting from electrical service: minimum of 45 lumens per watt — 5/20/01 — AJ

Exceptions: specialized signal, directional, and marker ltg.
lighting highlighting exterior features of historic building
lighting integral to advertising signage
safety or security lighting
low-voltage landscape lighting

Section 4 - Compliance Statement

11 *The proposed lighting design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2000 IECC lighting requirements using* COMcheck-EZ™ *Version 2.1.*

Principal Lighting Designer - Name	Signature	Date
Jeff A. Jackson, PE	Jeff A. Jackson, PE	10/5/00

NOTE: *This form is required on project plans. The Lighting Application Worksheet may be incorporated into the lighting schedule.*

Section 1 – Project Information

1 **Project Name** - name used to identify the project. ? Contact owner/agent.

2 **Address** - project site address. ? Contact owner/agent.

3 **Owner/Agent** - overall project representative; may be owner, project manager, or design professional of record. ? Contact owner/agent.

4 **Documentation Author** - individual responsible for filling out this certificate. ? Contact owner/agent.

EZ Tips

- The design professional of record, if required, should stamp and sign plans, specifications, and subsequent revisions.

Section 2 – General Information

5 **Building Floor Area** - total of all heated/cooled gross floor areas measured to outer wall surfaces; include lofts and mezzanines. ? Contact owner/agent.

6 **Project Description** - additions—add floor area and new lighting system(s); alterations—change an existing lighting system. ? See pages 4-7.

7 **Method of Lighting Compliance** - Tenant Area or Portion of Building applies to additions or alterations of existing building lighting systems. ? See pages 5-6.

Section 3 - Requirements Checklist

8 **Controls, Switching, and Wiring**

Independent controls for each space - indicate wiring and controls for each space with ceiling height partitions on the plans. ? See page 2.

Master switch at entry to each hotel/motel guest room - if applicable, indicate wiring arrangement and master switch for each room on the plans. ? See page 2.

Two switches, dimmer, or occupancy sensor in each space - indicate wiring arrangement for these controls for each space on the plans; provide manufacturer cut sheets if required. ? See pages 2-3.

Photocell or astronomical time-switch on exterior lights - indicate these controls for each space on the plans; provide manufacturer cut sheets if required. ? See page 3.

Tandem-wired one-lamp and three-lamp ballasted luminaires (lights) - indicate these controls for each space on the plans; provide manufacturer cut sheets if required. ? See pages 3-4.

EZ Tips

- The Documentation Author confirms that plan details show all controls, switching, dimmers, occupancy sensors, exterior-light switching, lamp details, and claimed exceptions; notes listed exceptions on plans; provides manufacturer cut sheets as required.
- The Plan Checker verifies that required controls, switching, and wiring are indicated on the plans; requires manufacturer cut sheets when needed to verify compliance.
- The Field Inspector verifies that required controls, switching, and lighting fixtures are consistent with the plans (rough lighting, final).

9 **Interior Lighting**

Interior Lighting - total interior lighting wattage, including lamp ballasts, is included in calculations; subtract lighting exempt areas and associated wattages; reconcile all design details with plans. ? See pages 4-5.

Allowed Watts - use lighting application worksheet, building-type definitions, and design areas to compute allowed wattage. ? See pages 4-5, 7.

Actual Watts - use actual power lighting worksheet, typical fixture wattage, and building type definitions to compute total actual watts. ? See pages 8-11.

Lighting Complies - total actual wattage must be less than or equal to the total allowed wattage. ? See page 6.

EZ Tips

- The Documentation Author calculates the allowed and actual watts using the Lighting Application Worksheet and enters the values in the box provided on the Lighting Compliance Certificate; ensures worksheet entries are consistent with plan details; confirms and designates any exceptions that are claimed.
- The Plan Checker compares the calculations with the lighting plan and verifies that all **nonexempt** fixtures are included in the calculations; verifies that worksheet entries are consistent with plans.
- The Field Inspector verifies that fixture types, individual fixture wattages, and number of fixtures are consistent with plans (rough electrical, final).

10 **Exterior Lighting**

Types of exterior lighting - locate and label all exterior lighting on plans and specifications by type and size. ? See page 7.

(a) **Power for lighting exceptions** - locate and label all lighting exceptions on plans and specifications. ? See page 7.

EZ Tips

- Project specifications should include sufficient detail and manufacturer's literature to verify compliance with requirements. Provide a lighting schedule that shows fixture type and details. Ensure fixture locations shown on plans are keyed to the schedule.
- The Documentation Author reconciles listed requirements with plan and specification details; confirms exceptions and provides manufacturer cut sheets as required by plan review for equipment.

- The Plan Checker checks and approves plans and specifications for sufficient requirement details for the three allowable high-efficiency lighting types with an efficacy of at least 45 lumens per watt; document claimed lighting exceptions.
- The Field Inspector checks to ensure lighting is fluorescent, metal halide, or high-pressure sodium; that it has an efficacy of at least 45 lumens per watt; and that any other lighting falling under claimed exceptions is listed on the approved plans and specifications (final).

Section 4 – Compliance Statement

11 **Principal Lighting Designer - Name** - If required by the code official, documentation author or design professional of record must print his/her name, sign, and date the certificate in the boxes provided to acknowledge that the structure has been designed to meet the 2000 IECC lighting requirements using COM*check*-*EZ* Version 2.1.

EZ Tips for Lighting Enforcement

Plan Check

- Verify that required controls, switching, lighting fixture types, and wiring are indicated on the plans; require manufacturer cut sheets when needed to verify compliance.
- Verify that the worksheet entries are consistent with the plans; check the calculations on the Lighting Application Worksheet and the values transferred to the Lighting Compliance Certificate.
- Verify that all outside lights served by the building's electrical system are identified on the plans as fluorescent, metal halide, high-pressure sodium, or other lamps having an efficacy of at least 45 lumens per watt; all lamps qualifying for exceptions must be identified as such on the plans.

Field Inspection

- Verify that installed controls, switching, and lighting fixtures are consistent with the plans.
- Verify that fixture types, individual fixture wattages, and the number of fixtures are consistent with the plans.
- Verify that all outside lights served by the building's electrical system are consistent with the plans.

1 Sample Lighting Application Worksheet for the 2000 IECC

Section 1 - Allowed Lighting Power Calculation				
A	B	C	D	E
2 Building or Area Type	3 Entire Building (watts per sq ft)	4 Tenant Area or Portion of Building (watts per sq ft	5 Building or Space (sq ft)	6 Allowed Watts* (B or C x D)
Auditorium	NA	1.6		
Bank/financial institution[a]	NA	2.0		
Classroom/lecture hall[b]	NA	1.6		
Convention, conference or meeting center[a]	NA	1.5		
Corridor, restroom, support area	NA	0.8	***1,700***	***1,360***
Dining[a]	NA	1.4	***5,300***	***7,420***
Exercise center[a]	1.4	1.1		
Exhibition hall	NA	3.3		
Grocery store[c]	1.9	2.1		
Gymnasium playing surface	NA	1.9		
Hotel function[a]	NA	2.4		
Industrial work, < 20 ft ceiling height	NA	2.1		
Industrial work, ≥ 20 ft ceiling height	NA	3.0		
Kitchen	NA	2.2	***3,900***	***8,580***
Library[a]	1.5	1.8		
Lobby--hotel[a]	NA	1.9		
Lobby—other[a]	NA	1.0	***350***	***350***
Mall, arcade, or atrium	NA	1.4		
Medical and clinical care[b, d]	1.6	1.6		
Museum[b]	1.6	1.6		
Office[b]	1.3	1.5	***250***	***375***
Religious worship[a]	2.2	3.2		
Restaurant[a]	1.7	1.7		
Retail sales, wholesale showroom[c]	1.9	2.1		
School	1.5	NA		
Storage, industrial and commercial	0.6	1.0	***1,000***	***1,000***
Theater—motion picture	1.1	1.0		
Theater—performance[a]	1.4	1.5		
Other	0.6	1.0		
			Basic Allowed Watts (Subtotal)	*19,085*
*You may use only Column B or Column C. Do not use more than one column.				
Additional Power Allowances**				
7 F	8 G	9 H	10 I	11 J
Area Type/Allowance Type	Qualifying Power (watts)	Maximum Allowance (watts per sq ft	Area (sq ft)	Allowance Smaller of B or (C´ D)
Dining/Decorative	*2,160*	*1.0*	*5,300*	*2,160*
Lobby/Decorative	*600*	*1.0*	*350*	*350*
			Additional Allowed Watts (Subtotal)	*2,510*
			12 **Total Allowed Watts**	*21,595*

**Additional Power Allowances can be claimed for applicable allowance types (see explanations below which are keyed to building and area types in column A above).

a **Lighting for decorative purposes** – Up to 1.0 watt of additional power per sq ft of floor area can be claimed for decorative lighting that is in addition to the general lighting system and is separately controlled.

b **Lighting for visual display terminals** – Up to 0.35 watt of additional power per sq ft of floor area can be claimed to meet the requirements of visual display terminals (VDT) where VDT use represents the primary viewing task.

c **Merchandise display** – Up to 1.6 watt of additional power per sq ft of display area can be claimed for lighting installed to highlight specific merchandise provided the display lighting is separately controlled from the general lighting system. For display of fine merchandise, such as jewelry, fine apparel, and china, up to 3.9 watts of additional power per sq ft of actual case or shelf area can be claimed.

d **Emergency medical spaces** - Up to 1.0 watt of additional power per sq ft of floor area can be claimed for emergency, recovery, medical supply, and pharmacy spaces.

Section 2 - Actual Lighting Power Calculation					
13 A	14 B	15 C	16 D	17 E	18 F
Fixture ID	Fixture Description	Lamp/Ballast	Quantity	Watts per Fixture	D x E
FL1	*2x4 Fluor.direct/louvered*	*2-T8/Elec.*	*11*	*65*	*715*
FL2	*2x4 Fluor.direct/lensed*	*2-T8/Elec.*	*155*	*65*	*10,075*
FL3	*2x4 Fluor.direct/indirect*	*2-T8/Elec.*	*20*	*65*	*1,300*
FL4	*Fluor. Linear Wallwash*	*1-T8/Elec.*	*9*	*32*	*288*
CF1	*Compact FL Wall Sconce*	*2-13W CF/Mag.*	*30*	*34*	*1,020*
CF2	*Compact FL Rec. Downlt.*	*2-18W CF/Elec.*	*23*	*35*	*805*
TH1	*Halogen Recessed Downlt.*	*1-60W Halogen*	*36*	*60*	*2,160*
INC1	*Incand. Rec. Downlt.*	*1-75W Incand.*	*28*	*75*	*2,100*
TH2	*Halogen Track Light*	*1-60W Halogen*	*46*	*60*	*2,760*
				Total Actual Watts	*21,223*

Section 3 - Compliance Calculation		
1	Total Allowed Watts	*21,595*
2	Total Actual Watts*	*21,223*
3	19 Project Compliance (line 1 - line 2; must be zero or greater)	*372*

* Include watts from above plus watts from continuation sheet(s), if any.

Completing Lighting Application Worksheet

Use the Lighting Application Worksheet to calculate the maximum allowed lighting power for the building interior and the total actual lighting power of the design to determine compliance. **If line 3 of the worksheet is not zero or greater after completing the calculations, the design does not comply and must be revised until it complies.** The numbered circles in these instructions correspond to those on the Sample Lighting Application Worksheet.

Section 1 - Allowed Lighting Power Calculation

1. **General Requirements** - supply all requested information at the level of detail indicated; do not substitute "see plans or specifications" for required information. ? See pages 4-6.

2. **Building or Area Type** - select the **main** building occupancy type or area use from those listed (see Building and Area Types following blank worksheet for descriptions). ? See pages 4-6.

3. **Entire Building OR** 4 **rea or Portion of Building** - select either Entire Building or Tenant Area column for power allowances; you must use one column or the other, not both. Depending on building usage, you may not have the option of using the Entire Building column. ? See pages 4-6.

5. **Building or Space** - total gross floor area of each building or area measured between inside-wall surfaces; include lofts and mezzanines. ? See pages 4-6.

6. **Basic Allowed Watts** - multiply the wattage value(s) from either the building or space by the corresponding area(s) and add to get the Total Allowed Watts. ? See pages 4-6.

Additional Power Allowances

7. **Area Type / Allowance Type** – enter the area type from Column C and allowance type from the table end notes of the fixtures qualifying for the additional power allowance. ? See pages 4-6.

8. **Qualifying Power** – enter the input wattage of the fixtures qualifying for the allowance. ? See pages 4-6.

9. **Maximum Allowance** – enter the maximum allowance permitted for the selected allowance type—see table end notes. ? See pages 4-6.

10. **Area** – enter the area served by the fixtures qualifying for the allowance. The way this area is determined depends on the allowance type—see table end notes. ? See pages 4-6.

11. **Additional Power Allowance** – enter the smaller of the qualifying power or the maximum allowance times the area. ? See pages 4-6.

12. **Total Allowed Watts** – sum the power allowances, then add in the Basic Allowed Watts to determine Total Allowed Watts for the building. ? See pages 4-6.

Section 2 - Actual Lighting Power Calculation

13 **Fixture ID** - list fixture identification names used in the project plans, specifications, and/or lighting schedule.

? See pages 5-6, 8-9.

14 **Fixture Description** - describe the basic lighting fixture types including lamp source type; e.g., fluorescents, compact fluorescents, halogen, etc.

? See pages 5-6, 8-9.

15 **Lamp/Ballast** - describe the lamps and ballasts including number of lamps, lamp type, and ballast type; e.g., magnetic or electronic.

? See pages 5-6, 8-9.

16 **Quantity** - refers to fixture count and not the number of lamps per fixture.

? See pages 5-6, 8-9.

17 **Watts per Fixture** - include input wattages for lamps and ballasts for all fixtures used in the project design; fixture wattage should be obtained from the manufacturer's specifications or taken from the Typical Lighting Wattage tables, if actual fixture input wattages are not available.

? See pages 5-6, 8-9.

18 **D x E** - multiply the quantity by the watts-per-fixture values and add the column to get Total Actual Watts.

? See pages 5-6.

Section 3 - Compliance Calculation

19 **Project Compliance** - copy the Total Allowed Watts and Total Actual Watts from above and calculate the difference; continue to revise the design if the Project Compliance value is not zero or greater.

? See pages 5-6.

EZ Tips

- Using values from the Typical Lighting Wattage tables can save time as an alternative to looking up values in manufacturers' catalogues. However, fixtures actually used must be at least as efficient as fixtures represented in the tables.

Lighting Compliance Certificate for the 2000 IECC

ALL INFORMATION MUST BE FILLED IN - PRINT CLEARLY

Section 1 - Project Information

Project Name		**Permit #**
Address		**Date**
Owner/Agent	Telephone	**Checked By**
Documentation Author	Telephone	**Date**
		For Department Use Only

Section 2 - General Information

Building Floor Area			
Project Description	☐ New Construction	☐ Addition	☐ Alteration
Method of Lighting Compliance	☐ Entire Building	☐ Tenant Area or Portion of Building	

Section 3 - Requirements Checklist

Controls, Switching, and Wiring	**Inspection Date**	**Approved By**	**Notes**
Independent controls for each space (switch/occupancy sensor) Exceptions: security lighting building lobby/retail store/mall			
Master switch at entry to each hotel/motel guest room			
Two switches, dimmer, or occupancy sensor in each space providing a uniform illumination pattern Exceptions: the area has only one luminaire an occupant-sensing device controls the area the area is a corridor, storage area, restroom, or lobby			
Photocell or astronomical time-switch on exterior lights Exception: large covered areas requiring lighting during daylight hours			
Tandem-wired one-lamp and three-lamp ballasted luminaires Exceptions: electronic high-frequency ballasted luminaires luminaires not on same switch			

Interior Lighting

Total actual watts must be less than or equal to total allowed watts

Allowed Watts	**Actual Watts**	**Lighting Complies (Y/N)**

External Lighting

Type(s) of exterior-lighting sources:

☐ fluorescent ☐ metal halide ☐ high-pressure sodium

Lighting from electrical service: minimum of 45 lumens per watt

Exceptions: specialized signal, directional, and marker ltg.
lighting highlighting exterior features of historic building
lighting integral to advertising signage
safety or security lighting
low-voltage landscape lighting

Section 4 - Compliance Statement

The proposed lighting design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2000 IECC lighting requirements using COM*check-EZ*™ *Version 2.1.*

Principal Lighting Designer - Name	**Signature**	**Date**

NOTE: *This form is required on project plans. The Lighting Application Worksheet may be incorporated into the lighting schedule.*

Lighting Application Worksheet for the 2000 IECC

Section 1 - Allowed Lighting Power Calculation				
A	**B**	**C**	**D**	**E**
Building or Area Type	**Entire Building (watts per sq ft)**	**Tenant Area or Portion of Building (watts per sq ft**	**Building or Space (sq ft)**	**Allowed Watts* (B or C x D)**
Auditorium	NA	1.6		
Bank/financial institution[a]	NA	2.0		
Classroom/lecture hall[b]	NA	1.6		
Convention, conference or meeting center[a]	NA	1.5		
Corridor, restroom, support area	NA	0.8		
Dining[a]	NA	1.4		
Exercise center[a]	1.4	1.1		
Exhibition hall	NA	3.3		
Grocery store[c]	1.9	2.1		
Gymnasium playing surface	NA	1.9		
Hotel function[a]	NA	2.4		
Industrial work, < 20 ft ceiling height	NA	2.1		
Industrial work, ≥ 20 ft ceiling height	NA	3.0		
Kitchen	NA	2.2		
Library[a]	1.5	1.8		
Lobby--hotel[a]	NA	1.9		
Lobby—other[a]	NA	1.0		
Mall, arcade, or atrium	NA	1.4		
Medical and clinical care[b, d]	1.6	1.6		
Museum[b]	1.6	1.6		
Office[b]	1.3	1.5		
Religious worship[a]	2.2	3.2		
Restaurant[a]	1.7	1.7		
Retail sales, wholesale showroom[c]	1.9	2.1		
School	1.5	NA		
Storage, industrial and commercial	0.6	1.0		
Theater—motion picture	1.1	1.0		
Theater—performance[a]	1.4	1.5		
Other	0.6	1.0		
			Basic Allowed Watts (Subtotal)	
*You may use only Column B or Column C. Do not use more than one column.				
Additional Power Allowances**				
F	**G**	**H**	**I**	**J**
Area Type/Allowance Type	**Qualifying Power (watts)**	**Maximum Allowance (watts per sq ft**	**Area (sq ft)**	**Allowance Smaller of B or (C ´ D)**
			Additional Allowed Watts (Subtotal)	
			Total Allowed Watts	

Section 2 - Actual Lighting Power Calculation					
A	B	C	D	E	F
Fixture ID	Fixture Description	Lamp/Ballast	Quantity	*W*atts per Fixture	D x E
				Total Actual Watts	
Section 3 - Compliance Calculation					
1				Total Allowed Watts	
2				Total Actual Watts*	
3				Project Compliance (line 1 - line 2; must be zero or greater)	

* Include watts from above plus watts from continuation sheet(s), if any.

Whole Building Types

Exercise center – A building or structure used for recreational activities involving physical exertion designed to promote physical fitness and well-being.

Grocery store – A building or structure that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Library – A building or structure in which literary and artistic materials, such as books, periodicals, and audiovisuals, are kept for reading, reference, and loan.

Medical and clinical care – A building or structure for the purpose of providing medical treatment, confinement or care, and sleeping facilities such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, and reformatories.

Museum – A building used for the display and preservation of objects of artistic, scientific, or cultural interest.

Office – A building or structure for office, professional, or service type transactions such as medical offices, banks, libraries, and government office buildings.

Religious worship – A building for worship, religious services, and associated social and educational functions.

Restaurant – A building or structure for the preparation and consumption of food or drink, including coffee shops, cafeterias, bars, and fast food and leisure restaurants.

Retail sales, wholesale showroom – A building or structure for the display and sale of merchandise such as shopping malls, food markets, auto dealerships, department stores, and specialty shops.

School – A building or structure for the purpose of instruction, such as schools, colleges, universities, and academies.

Storage, industrial and commercial – A building or structure for storage, such as aircraft hangars, garages, warehouses, storage buildings, and freight depots.

Theater—motion picture – An assembly room, hall, or building with tiers of rising seats or steps for the showing of motion pictures.

Theater—performance – An assembly room, hall, or building with tiers of rising seats or steps for the viewing of dramatic performances, lectures, musical events, and similar live performances.

Other – A building or structure whose intended use is currently not known or does not match any of the above categories.

Area Use Categories

Auditorium – An area with fixed seats used for public meetings or gatherings not specifically for the viewing of dramatic performances.

Bank / financial institution – An area for conducting financial transactions including the custody, loan, exchange, or issue of money, for the extension of credit, and for facilitating the transmission of funds.

Classroom / lecture hall – An area of a building where classes meet.

Convention, conference or meeting center – an area used for meetings, conventions, and multiple purposes, including dramatic performances, that has neither fixed seating nor fixed staging.

Corridor, restroom, support area – Corridor: an area used as a passageway to access compartments or rooms. Restroom: An area providing personal facilities such as toilets and washbasins. Support: An area used as a passageway, utility room, storage space, or other use associated with the building's primary function.

Dining – An area in a restaurant or hotel / motel (other than guest rooms) where meals served to the customers are consumed.

Exercise center – An area of a building for recreational activities involving physical exertion designed to promote physical fitness and well-being.

Exhibition hall – An area used for exhibition that has neither fixed seating nor fixed staging.

Grocery store – An area of a building that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Gymnasium playing surface – An area of a building for organized athletic games, such as basketball, volleyball, racquetball, and tennis.

Hotel function – An area such as a hotel ballroom, meeting room, exhibit hall, or conference room, together with prefunction area and other spaces ancillary to its function.

Industrial work, < 20 ft ceiling height – An area of a building in which a manufacturing operation, craft, or art is performed having a ceiling less than 20 ft above the floor.

Industrial work, ³ 20 ft ceiling height – An area of a building in which a manufacturing operation, craft, or art is performed having a ceiling 20 or more ft above the floor.

Kitchen – An area containing facilities for cooking and food preparation.

Library – An area of a building in which literary and artistic materials, such as books, periodicals, and audiovisuals, are kept for reading, reference, and loan.

Lobby—hotel – An area in a hotel/motel between the main entrance and the front desk, including waiting and seating areas, and other spaces encompassing the activities normal to a hotel lobby function.

Lobby—other – An area located directly inside the main entrance of a building and includes the reception area, sitting areas, and public areas.

Mall, arcade, or atrium – An area of a building used as a public passageway or concourse that provides access to rows of stores or shops.

Medical and clinical care – An area of a building where medical treatment is provided, such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, and reformatories.

Museum – An area of a building used for the display or preservation of objects of artistic, scientific, or cultural interest.

Office – An area of a building for office, professional, or service-type transactions such as medical offices, banks, libraries, and government office buildings.

Religious worship – An area of a building for worship or religious services.

Restaurant – An area of a building for the preparation and consumption of food or drink, including coffee shops, cafeterias, bars, and fast food and leisure restaurants.

Retail sales, wholesale showroom – An area of a building in which the primary activity is the sale of merchandise or the display of samples of merchandise.

Storage, industrial and commercial – An area of a building for storing items.

Theater—motion picture – An area of a building with tiers of rising seats or steps for the showing of motion pictures.

Theater—performance – An area of a building with tiers of rising seats or steps for the viewing of dramatic performances, lectures, musical events, and similar live performances.

Other – An area of a building whose intended use is currently not known or does not match any of the above types.

Software Compliance Guide

COM*check-EZ*

You can use COM*check-EZ*™ to demonstrate that your commercial or high-rise residential building design complies with the 2000 Edition of the International Energy Conservation Code (IECC). COM*check-EZ* includes a software method and a manual method for demonstrating compliance.

The COM*check-EZ* software provides a highly flexible way to demonstrate compliance with minimal input. The envelope section allows tradeoffs between envelope components, including roofs, walls, windows, floors, and skylights. The lighting section enables you to quickly determine if your lighting design meets interior-lighting power limits. The mechanical section enables you to assemble a customized list of code requirements that are applicable to the systems and equipment in your building.

This guide describes how to install and use the COM*check-EZ* software, Version 2 for Windows. If you have obtained a printed copy of these materials, a CD-ROM containing the software is attached to the inside back cover. You can access a U.S. Department of Energy Building Standards and Guidelines Program (BSGP) web site at http://www.energycodes.org to learn about COM*check-EZ* and get free downloads of the complete package of materials. If you have more questions, call the BSGP hotline at 1-800-270-CODE or send email to TechSupport@pnl.gov.

Getting Started

What You Need to Run COM*check-EZ*

COM*check-EZ* requires a Windows-based computer with at least the following hardware and software:

- an 80486 processor
- 6 MB extended RAM
- a VGA or Super VGA monitor
- a Microsoft-compatible mouse.

COM*check-EZ* Version 2 is a Windows application and requires Microsoft® Windows® 95, 98, NT 4.0 or later.

Installing COM*check-EZ*

You must install COM*check-EZ* onto your hard disk as instructed below. Before installing the software, make sure your computer meets the minimum hardware and software requirements.

To install COM*check-EZ* from the CD-ROM:

1. Insert the CD into the CD drive of your computer. The AutoRun dialog will automatically appear.
2. Select *Install COMcheck-EZ Software*.
3. To run the COM*check-EZ* software after installation, select *Programs* from the *Start* button and select COM*check* from the programs list. Alternatively, if you are using Windows Explorer or File Manager you can change to the COM*check* subdirectory and double-click on the COM*check* icon.

If the AutoRun dialog does not appear:

1. Select the *Start* button from the task bar and choose *Run* from the menu.
2. Type <source>\setup.exe (where <source> is the CD drive letter).
3. Click **OK** and follow the previous instructions.

Starting COM*check-EZ*

From the **Start** button, select ***P****rograms*, then select COM*check* from the programs list. Alternatively, if you are using Windows Explorer or File Manager you can change to the COM*check* subdirectory and double-click on the COM*check* icon.

Screen Layout

Title Bar - The title bar displays the name of the currently open project data file and the currently selected code. If no file is open, the word *Untitled* is displayed.

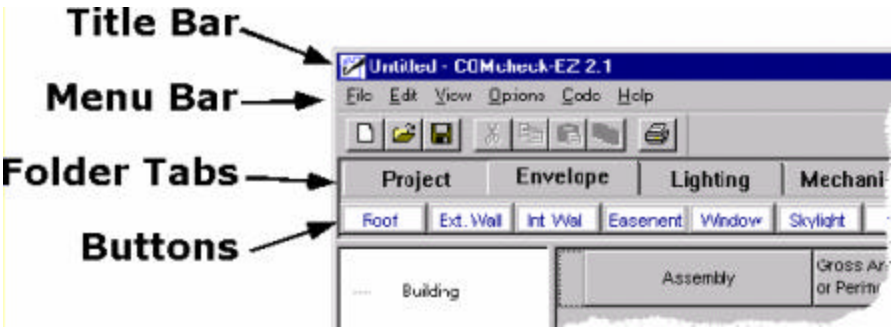
Menu Bar - The menu bar is located directly under the title bar and displays the available menus–***F****ile, **E**dit, **V**iew, **O**ptions, **C**ode,* and ***H****elp*. These menus are discussed in more detail in the following sections.

Folder Tabs - The *Project, Envelope, Lighting, and Mechanical* folder tabs are used to move between major sections of the program.

Buttons - The buttons located directly under the folder tabs are used to create a list of envelope, lighting, and mechanical components representing your design.

User Prompts and Status Messages - The bottom left corner of the screen displays user prompts and status messages.

Compliance Results - The bottom right corner of the screen displays color-coded compliance results as a percentage by which performance is better or worse than the minimum required by the code. For example, a +10.0% in green on white would indicate the proposed design passes the envelope requirements with heating plus cooling loads 10% below the maximum allowed. A -5.0% in red on white would indicate the loads exceed those allowed and must be reduced by roughly 5% to achieve compliance.



Partial Screen Layout

Text Colors Used in the Software

Colors Used In Table Fields

Black text on white background indicates the field is editable by the user.

Black text on gray background indicates the data were calculated by the program and are not directly editable by the user.

Dark blue text on white background indicates the data were selected from a drop-down list. Clicking on such fields with the left mouse button will redisplay the appropriate list.

Red-on-white text indicates data are either missing or not within a valid range.

White-on-red text is displayed in the *R-value* or *U-factor* field of an envelope assembly that violates a mandatory code requirement. A building DOES NOT comply if any R-value or U-factor violates a mandatory requirement, even if the overall envelope compliance index is positive.

Colors Used In Compliance Fields

Red-on-white compliance results indicate the design does not comply.

Green-on-white compliance results indicate the design does comply.

The letters *TBD* (to be determined) in ***blue on gray*** indicate you have provided insufficient data for a compliance calculation. To determine which data are invalid, look for fields with red on white text. In addition to providing inputs for all red on white fields, you must select at least one building use type on the *Project* screen before compliance can be determined.

Table Columns and Rows

Many of the main screens have grid-like tables used to enter and store data. You can delete, move, collapse, and expand the rows and columns in the tables.

Rows

To select a row, click on the leftmost column of that row (the column containing row numbers). The row will be reversed (black background) when correctly selected. You

can also select multiple rows by holding down the left mouse button on the left-hand column and dragging it over the desired rows.

Rows can be moved by:

1. selecting the row(s) to be moved (as described above),
2. releasing the mouse button,
3. clicking the mouse button on the leftmost column of any of the selected rows (a small box will appear at the tail end of the arrow cursor),
4. dragging the mouse to the new location-a thin red line will appear indicating where the row(s) should be placed,
5. releasing the mouse button when the red line has been placed in the desired location.

 Arrow cursor when dragging rows or columns.

On the main screens, a single table row can also be moved by dragging the corresponding row label in the tree located to the left of the table. Click the mouse on the desired label and drag it to another label on the tree. After releasing the mouse, the dragged label (and row) will be positioned directly under the label on which it was dropped. Some restrictions apply to the placement of rows. In the *Envelope* screen, for example, window and door rows can be placed only under exterior wall or basement wall rows. Skylight rows can be placed only under roof rows.

On the main screens, you can collapse and expand rows by using the tree located to the left of the table. Rows that fall below a "parent" row on the tree can be collapsed so they are not displayed. For example, an exterior wall row with several windows and doors under it can be collapsed to hide the windows and doors. A tree label with a minus sign to the left of the label is already expanded. It can be collapsed by clicking on the box containing the minus sign. Tree labels that are already collapsed have a plus sign to the left of the label. They can be expanded by clicking the box containing the plus sign. Clicking the plus or minus sign to the left of the *Building* label will expand or collapse all rows in the table.

Columns

You can move table columns by selecting a single column by clicking the left mouse on the column heading. Select multiple columns by pressing the left mouse and dragging it over the desired column headings. Selected columns will be reversed (black background).

Columns can be moved by:

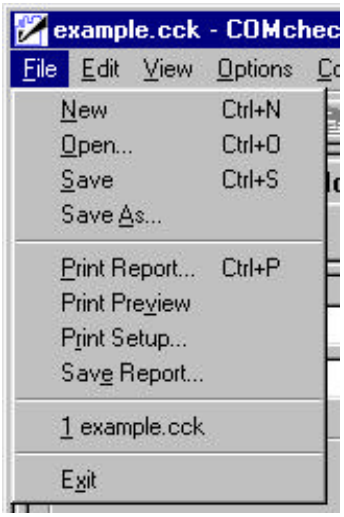
1. selecting the column(s) to be moved (as described above),
2. releasing the mouse button,
3. clicking the mouse button on the column heading of any of the selected columns (a small box will appear at the tail end of the arrow cursor),
4. dragging the mouse to the new location-a thin red line will appear indicating where the column(s) should be placed,
5. releasing the mouse button when the red line has been placed in the desired location.

Table column widths can be modified by moving the mouse over the right edge of the corresponding column header until the mouse pointer changes to a double-sided arrow until the mouse pointer changes to a double-sided arrow. 

When the mouse pointer changes, drag the column to the desired width. Columns that have been totally collapsed can be restored by double-clicking the mouse on the column header separation (the vertical line in the top row representing the hidden column).

File Menu

Use the ***F**ile* menu to open existing project data files (**O***pen*) and save your project data (***S**ave*). The ***N**ew* option allows you to erase the current data and begin a new project data file. The *Save **A**s* option allows you to save your current project data file to a new name. The program provides options for previewing and printing compliance reports, and for directing output to selected printers (*Print Pre**v**iew*, ***P**rint Report*, and *Pr**i**nt Setup*, respectively). You can also save the compliance report to a file in rich text format [rtf] (*Sav**e** Report*) for inclusion in another document. An example building file is provided with the software.



File Menu

Edit Menu

Use the ***E**dit* menu to cut, copy, paste, and duplicate data in the tables. You can also click the right mouse button on any field or tree label to display a pop-up list with these same options (see *Context Menu*).

Edit Menu

The edit commands can be applied to individual table cells, to a selected table row, or to multiple selected rows. To select multiple rows, press the left mouse button on the left-

hand column and drag it over the desired rows. The rows will be reversed (black background) when correctly selected.

Cut

Use the *Cut* option to delete the highlighted text in a cell. You can paste the deleted text into another cell of the same type. If one or more rows in the table are selected, the rows will be deleted.

Copy

Use the *Copy* option to copy the highlighted text in a cell. The copied text can be pasted into another cell of the same type. You can also copy an entire row by selecting the row and choosing *Copy* from the *Edit* menu or clicking the right mouse button on the tree label corresponding to that row.

Paste

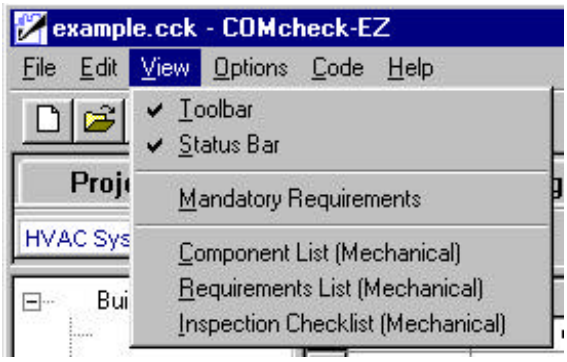
Use the *Paste* option to paste the last copied text into a selected cell or row. Note that you can only paste cell data or row data of the same type. For example, you can paste a row containing a roof assembly into another row containing a roof assembly, but not into a row containing a window assembly.

Duplicate

Use the *Duplicate* option to duplicate an entire row. You can only duplicate rows; not individual fields.

View Menu

Use the *View* menu to view or hide software features.



View Menu

Toolbar and Status Bar

The *Toolbar* and *Status Bar* options hide or display the Toolbar or Status Bar.

Mandatory Requirements

The ***M**andatory Requirements* option displays requirements that must be met by all buildings in addition to the requirements determined to be applicable by the software. You may view and print separate mandatory requirements for Envelope, Lighting, and Mechanical.

Component List (Mechanical)

The ***C**omponent List* option displays a table on the right side of the *Mechanical* screen. The table contains all HVAC system, plant, and water-heating components you have created. The table also contains a column for entering the quantity of each component.

Requirements List (Mechanical)

The ***R**equirements List* option displays a comprehensive description of requirements applicable to the selected component or system. If you select the *Building* label in the tree at the left of the screen, the list of requirements applicable to all building systems is displayed. If you select a specific mechanical component label in the tree, the requirements applicable to only that component are displayed.

Inspection Checklist (Mechanical)

The ***I**nspection Checklist* option is another way to view the lists of requirements. This option displays the same lists of requirements as the ***R**equirements List* option but in an abbreviated (checklist) format. Selecting the *Building* label in the tree displays the list of requirements for the building. Selecting a specific mechanical component label displays the requirements applicable to only that component.

Options Menu

Use the ***O**ptions* menu to toggle optional software features on or off. All features under the ***O**ptions* menu are optional--none are required to demonstrate compliance.

Options Menu

Orientation (Envelope)

Use the ***O**rientation* option to add a column to the *Envelope* screen to select *North*, *East*, *South*, or *West* orientations for each exterior wall, window, door, and basement wall assembly. If an orientation is selected for an assembly linked to other assemblies (such as a window linked to an exterior wall), the orientation for all of the linked assemblies is changed to match the new selection.

If an orientation has been assigned to each wall, window, door, and below-grade wall assembly, the compliance calculation will be based on a proposed building using those orientations. This result may be slightly different than the result obtained when orientation is not specified. In the latter case, assemblies are assumed to be equally distributed according to a code-specified aspect ratio. The orientation-specific compliance calculation will not be performed until ***all*** assemblies have been assigned an orientation.

Daylight Control Factor (Envelope)

If you select ***D****aylight Control Factor*, COM*check-EZ* adds two columns to the *Envelope* screen--*DLCF* (daylight control factor) and *VLT* (visible light transmittance). To receive credit for DLCFs, you must enter the DLCF for all exterior wall, window, and door components; the VLT for each window; and the orientation of each exterior wall, window, door, and basement wall assembly.

The daylight control factor (DLCF) option offers modest credit toward envelope compliance where automatic lighting controls for daylight use are used. To activate this option, select ***D****aylight Control Factor* from the ***O****ptions* menu. When this option is selected, two new columns are added to the table on the *Envelope* screen. The *VLT* column is used to enter the visible light transmittance (VLT) of windows. The *DLCF* column is used to enter the daylight control factor.

The DLCF is the fraction of the installed lighting power within 15 ft of the exterior wall that will be automatically controlled for daylight use. The software accepts values from 0.0 to 1.0. If the lights will not be controlled for daylight use, the appropriate value to use is zero.

DLCF is an attribute of a daylit exterior zone, of which windows, the electric lighting systems, and the daylight control systems are parts. Thus, whatever DLCF value you enter applies uniformly to all components of the daylit zone, which includes an exterior wall and all windows and doors that penetrate the wall. Changing the DLCF for one of these components changes it for them all. To calculate DLCF, sum the wattage of all electric lights in a 15-ft deep daylit zone that runs the length of the exterior wall, then calculate the decimal fraction of that wattage controlled by daylight sensors.

This feature of the code is intended to permit the use of higher window-wall ratios and higher VLT glazings when used in conjunction with automatic lighting controls for daylighting. Use of DLCF and VLT are only appropriate where such controls are to be used.

The DLCF is dependent on orientation, so components must be entered using the ***O****rientation* option if *Daylight Control Factor* is selected. If the ***O****rientation* option was not previously selected, the software will automatically select it and add the *Orientation* column to the table. If a DLCF is entered for an assembly linked to other assemblies (such as a window linked to an exterior wall), the DLCF for all linked assemblies is changed to match the new value.

Visible Light Transmittance (Envelope)

VLT is the decimal fraction of visible light that passes through the window. The software accepts values from 0.0 to 1.0. See manufacturer's literature for the correct value to use with your selected glazing product. For a typical VLT value for the glazing characteristics you have selected, click with the right mouse button on the VLT input field and select *Use Typical*. The *Use Typical* feature provides values that can be used in preliminary evaluations before actual product selections have been made. The VLT input column is displayed only after the DLCF option has been selected from the ***O****ptions* menu and provides benefit only when used in conjunction with DLCF.

Spaces (Lighting)

The *Spaces* option allows you to link lighting fixtures to spaces within the building. The tree on the left side of the *Lighting* screen shows the linkage between each space and the fixtures within it. The *Spaces* option is recommended because it simplifies verification of fixture counts.

Exemptions and Allowances (Lighting)

To identify an exempt fixture, first make sure ***E****xemptions and Allowances* is checked in the ***O****ptions* menu.

Exemptions

To use the optional exemptions feature, click the mouse on the *Exemption/Allowance* column of that fixture. A pop-up list will be displayed giving you a choice of *None*, *Exemption*, or *Allowance*; select *Exemption*. A second list will be displayed giving you a choice of the types of exemptions available under the code. Select the type of exemption that applies to the fixture type, or *None* if the fixtures do not qualify for an exemption. When a set of lighting fixtures is identified as exempt, the power for the fixtures is omitted from the wattage total for the building. We recommend that all fixtures-both exempt and nonexempt-be listed in order to clarify where exemptions have been claimed and to streamline plan review and inspection.

The 2000 IECC permits fixtures used for the following purposes to be treated as exempt from inclusion in interior lighting power totals:

1. Special Medical/Dental/Research Lighting
2. Professional Sports Arena Playing Field Lighting
3. Gallery/Museum/Monument Exhibits
4. Lighting in Residential Dwelling Units - including guest room lighting in hotels, motels, boarding houses, high-rise multifamily housing, and similar buildings
5. Emergency Lighting (Automatic Control) – emergency lighting that is automatically off during normal building operation

Allowances

To use the optional allowances feature, click the mouse on the *Exemption Allowance* column of that fixture. A pop-up list will be displayed giving you a choice of *None*, *Exemption*, or *Allowance*--select *Allowance*. A second pop-up will list the allowances available for that fixture, and a third pop-up will list the building use types that can be used for that allowance. The following allowances may be claimed under the 2000 IECC code:

Decorative – qualifying lighting 1) must be for decorative purposes, 2) must be in addition to general lighting, 3) must be controlled on separate circuits from general lighting, and 4) the entered area must include only the floor area of the space containing the decorative lighting.

Visual Display Terminals – qualifying lighting 1) must be installed to meet requirements of visual display terminals (VDT) as the primary viewing task and 2) for the entered area, must include only the floor area of the space containing the VDT lighting.

Merchandise Display – qualifying lighting must be 1) installed to highlight specific merchandise, 2) in addition to general lighting, 3) and controlled on separate circuits

from general lighting; the entered area must be the area of the specific merchandise display and NOT the floor area of the space.

Fine Merchandise Display – qualifying lighting must be 1) installed to highlight fine merchandise such as jewelry, fine apparel, and accessories or china and silver, 2) in addition to general lighting, 3) and controlled on separate circuits from general lighting; the entered area must be the area of the actual case or shelf area for displaying and selling fine merchandise and NOT the floor area of the space.

Emergency Medical/Pharmacy – qualifying lighting must be installed in spaces designed for emergency, recovery, medical supply, or pharmacy.

Allowances are only available for certain whole building types and area category types and can only be taken if one of these building types has already been created on the *Project* screen. If none of the applicable building use types has been created, the *Allowance* option will be disabled (gray). The following table lists the building use types for which power allowances are permitted, the applicable allowance type, and the maximum allowance in W/ft^2 that is applied by the software.

Whole Building Type	Area Category	Allowance Type	Allowance (W/ft^2)
---	Bank/Financial Institution	Decorative	1.0
---	Classroom/Lecture Hall	Visual Display Terminals	0.35
---	Convention, Conference or Meeting Center	Decorative	1.0
---	Dining	Decorative	1.0
Exercise Center	Exercise Center	Decorative	1.0
Grocery Store	Grocery Store	Merchandise Display	1.6
---	Hotel Function	Decorative	1.0
Library	Library	Decorative	1.0
---	Lobby-Hotel	Decorative	1.0
---	Lobby-Other	Decorative	1.0
Medical and Clinical Care	Medical and Clinical Care	Visual Display Terminals Emergency Medical/Pharmacy	0.35 1.0
Museum	Museum	Visual Display Terminals	0.35
Office	Office	Visual Display Terminals	0.35
Religious Worship	Religious Worship	Decorative	1.0
Restaurant	Restaurant	Decorative	1.0
Retail Sales, Wholesale Showroom	Retail Sales, Wholesale Showroom	Merchandise Display Fine Merchandise Display	1.6 3.9
Theaters-Performance	Theaters-Performance	Decorative	1.0

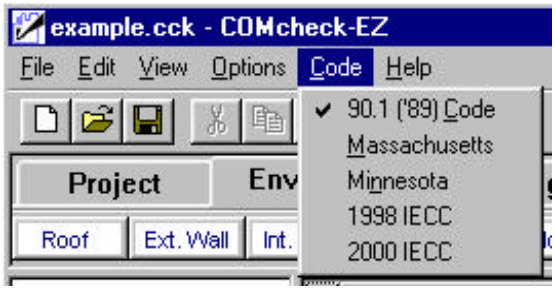
After selecting the building use type, a dialog appears asking for the floor area (ft^2) that the allowance applies to. The software will not allow entry of a floor area larger than the floor area indicated on the *Project* screen for that building use type. The software

multiplies the allowance (listed in the third column of the table above) by the square footage entered in this dialog to determine the amount of additional wattage added directly to the *Allowed Wattage* total. This allowance, however, cannot exceed the total proposed wattage of the fixture(s) (the *Number of Fixtures* times the *Fixture Wattage*).

The selected allowance, building use type, and floor area are copied to the *Exemption Allowance* field on the *Lighting* table. You can expand this field to read the entire entry by dragging the right grid line of the *Exemption Allowance* column header to the right.

Code Menu

Use the ***C**ode* menu to select which code version you want the program to use when determining compliance.



Code Menu

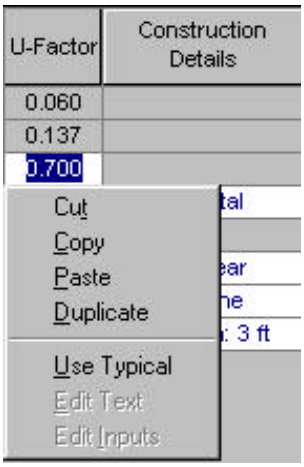
Help Menu

The ***H**elp* menu provides general information on how to use COM*check-EZ*. The ***H**elp Topics* option displays all of the Help topics within COM*check-EZ*. The ***A**bout COMcheck-EZ* option displays the program's version number and release date.

Help Menu

Context Menu

Clicking the right mouse button on a tree label or table displays a pop-up list, referred to as a context menu. The context menu options are applied to a single field in a table or to an entire row in a table, depending on where the mouse is clicked. If the mouse is clicked on a tree label, the menu options are applied to the row corresponding to that label. If the mouse is clicked on the left field of a row in a table, the options are applied to the entire row. Some options are applicable to individual fields of a table, and the mouse must be clicked on the given field to activate the option.



Context Menu

Cut, Copy, Paste, and Duplicate

The *Cut*, *Copy*, *Paste*, and *Duplicate* options are available from the *Edit* menu in the menu bar, from toolbar buttons, and from the context menus. See the previous section on the *Edit* menu for a description of these options. The *Cut*, *Copy*, and *Paste* options can be applied to individual fields in a table as well as to entire rows. The *Duplicate* option, however, is always applied to an entire row or rows.

You cannot copy a row of one type and paste it over a row of another type. For example, you cannot copy a row in the *Envelope* table containing a roof component and paste it in a row already containing a window component--this will generate an error message.

Use Typical

The *Use Typical* option enables you to enter a common value for products having the characteristics you have selected. You can use this feature in initial compliance checking before actual products have been selected. **However, products used in the building must meet or exceed the performance you assume in the compliance analysis.**

The *Use Typical* option places a common value into an individual field of a table. For example, after selecting a window component and describing the glazing and frame characteristics of that window, you can right-click the *U-Factor* column of the window component and select the *Use Typical* option from the context menu. The software will supply a window U-factor that is "typical" for a window with those characteristics. Select *Use Typical* by right-clicking on the *SHGC* column or the *VLT* column, and the software will provide a typical solar heat gain coefficient (SHGC) value or a typical visible light transmittance (VLT) value for the window.

You can also right-click in the *Fixture Wattage* column on the *Lighting* screen; then select *Use Typical* to have the software provide a typical fixture input wattage, i.e., for the lamp/ballast combination.

Edit Text

The *Edit Text* option is used to edit the text on a tree label. When you create a new envelope assembly, lighting fixture, or mechanical component, a new row appears in the corresponding table and a new tree label appears on the tree to the left. The tree labels are assigned default names such as *Roof 1* or *Incandescent 2*. These labels can be

changed by clicking the right mouse button on the label and selecting ***E**dit Text* from the context menu. An edit box will become visible where the label used to be, and you can rename the label by typing in the edit box. Press **Enter** or click elsewhere when finished. You can enter a maximum of 128 characters in the edit box. You can also edit tree labels by double-clicking on the label.

Edit Inputs

The *Edit **I**nputs* option is only available when right-clicking on a tree label in the *Mechanical* screen. The *Mechanical* screen components are created using pop-up screens (called dialogs) or a series of such screens (called a wizard). If you want to change any of the inputs for a particular mechanical component, click the right mouse button on the tree label for that component and select *Edit System Inputs*, *Edit Plant Inputs*, or *Edit SWH Inputs* (the context menu option changes depending on which type of mechanical component you have selected). The input screen(s) will be redisplayed with your original inputs, which you can change.

Project Screen

The *Project* screen is used to provide the software with information such as: 1) the location of the proposed building (state and city) and 2) the building use category and area. You may also enter specific project information that identifies and describes your project.

Location

COM*check-EZ* lists the available cities for each state. If your city is not listed, choose the closest city with similar weather conditions or consult with your local building department.

Building Use

Use the *Whole Building* compliance method for buildings that entirely match one of the available building types. Use the *Area Category* compliance method for mixed-use buildings when detailed information about space usage is available. For some projects, you may have a choice of which compliance method to use.

A list of building types or area categories is displayed when you click the left mouse in the *Whole Building Type* or *Area Category* column of the *Building Use* table. The *Assembly*, *Hotel*/*Motel*, and *Multifamily* options displayed in the whole-building types list are only available for envelope compliance. To make them available, you must select the *Envelope and/or Mechanical Compliance Only* checkbox. If lighting compliance is to be determined for one of these building types, you must use the area category method of compliance.

Envelope Screen

Use the blue-on-white buttons at the top of the *Envelope* screen to create a list of building components present in your proposed design. Each component you select is added to the building components displayed on the *Envelope* screen. For each component, enter appropriate values for all fields with white backgrounds. These fields may include the assembly type, area (or perimeter), cavity R-value, continuous R-value, assembly U-factor, construction details, SHGC, and/or projection factor. To view an example building description, load the EXAMPLE file.

Concrete slab-on-grade components require a perimeter entered in linear feet. All other components require an area entered in square feet. The cavity R-value input is used for insulation placed between structural members, while the continuous R-value input is used for insulation that is continuous across the structure such as rigid-roof insulation or insulating wall sheathing.

After you have completed the description of each new component, the program automatically updates the compliance results. The results are displayed at the bottom of the screen in the *Envelope* box. If *TBD* (to be determined) is displayed in this field, you have not filled in all necessary fields. To determine which data are missing or invalid, look for fields with red-on-white text. In addition to providing inputs for all red-on-white fields, you must select at least one building use type and provide its area on the *Project* screen before the software can determine compliance.

Roofs

Roofs include portions of the building envelope that are above conditioned space and are horizontal or tilted at less than 60 degrees from horizontal.

Select the *Roof* button to add a roof component to the description of your design on the *Envelope* screen. Enter each unique roof assembly as a separate component. You can enter multiple roof elements sharing the same construction as one component with appropriate total area.

Roof Types

1. *All-Wood Joist/Truss* - wood frame roof structures in which insulation is placed between structural roof members; e.g., batt or loose-fill insulation in cathedral ceilings or attic spaces.
2. *Nonwood Joist/Truss* - metal frame roof structures in which insulation is placed between structural roof members; e.g., steel bar joists or trusses with metal webs having insulation below the roof deck.
3. *Structural Slab* - any roof structure in which the roof is insulated primarily or exclusively using continuous rigid insulation above the roof deck.
4. *Metal Roof without Thermal Blocks* - metal building roofs where roof insulation is draped across metal structural members and metal roofing is attached to the structural members without rigid insulating spacers.
5. *Metal Roof with Thermal Blocks* - metal building roofs where roof insulation is draped across metal structural members and rigid insulating spacers are used between structural members and metal roofing. Because the thermal performance of metal building components is sensitive to assembly and fastener details, you may find it advantageous to enter these assemblies using the *Other* category and U-factors from manufacturers' literature.
6. *Other* - roof assemblies that do not fit in one of the above five categories (see **Assembly U-Factor** under Roof Software Inputs).

Roof Software Inputs

Gross Area or Perimeter

Enter the gross area of the roof component in the *Gross Area or Perimeter* field. The gross roof area includes the area of all skylights that penetrate the roof. Skylights are shown below the roof to which they belong on the tree control on the left side of the *Envelope* screen. To change the linkage of a skylight to a roof assembly, drag the

skylight label on the tree to a new roof label and release the mouse. The roof area should be measured along the insulated boundary between conditioned and unconditioned space (e.g., along sloping rafters if the roof insulation follows the slope of the roof).

Cavity Insulation R-Value

Enter the R-value of any insulation to be installed in the cavities between roof structural members. All R-values should be rated R-values for insulation materials only. These values are commonly printed on the materials. The insulating values of other parts of the building assemblies (e.g., ceilings and air films) are already accounted for by the software based on assembly type.

Continuous Insulation R-Value

Enter the R-value of any continuous roof insulation. Continuous insulation is insulation that runs continuously over structural members and is free of significant thermal bridging; one example is rigid foam insulation above the roof deck. All R-values should be rated R-values for insulation materials. The insulating values of other parts of the building assemblies (e.g., ceilings and air films) are already accounted for by the software based on assembly type.

Assembly U-Factor

If you have selected the *Other* roof type, enter the overall U-factor of the roof assembly, including exterior and interior air films. Do not include the finished ceiling in the U-factor calculation if the space between ceiling and roof structure is used as an HVAC plenum. Building departments may require supporting documentation for assemblies entered using the *Other* roof category and *U-Factor* field.

Exterior Walls

Select the *Ext. Wall* button to add an exterior above-grade wall to the description of your design on the *Envelope* screen. Each unique above-grade wall assembly should be entered as a separate component, but multiple wall elements sharing the same construction and orientation (if used) may be entered as one component with appropriate total area.

Exterior and Interior Wall Types

- *Wood Frame, Any Spacing* - wood frame walls of any stud depth or spacing. The category is intended primarily for lightweight walls but may also be used for walls with masonry veneers.
- *Metal Frame, 16" o.c.* - metal frame (stud) walls of any gauge or depth, spaced 16" o.c. The category is intended primarily for lightweight walls but may also be used for walls with masonry veneers.
- *Metal Frame, 24" o.c.* - metal frame (stud) walls of any gauge or depth, spaced 24" o.c. The category is intended primarily for lightweight walls but may also be used for walls with masonry veneers.
- *Metal Wall Without Thermal Blocks* - metal building walls where wall insulation is draped across metal structural members and metal siding is attached directly to the structural members without rigid insulating spacers.
- *Structural Masonry Walls* - a wall construction category used with masonry, precast, and poured-in-place concrete, and concrete masonry units. You can select from six specific types of masonry wall.

- Solid Concrete or Masonry <= 8" - solid precast or poured-in-place concrete, as well as concrete masonry units with grouted cells and actual thickness of 8" or less.
- Solid Concrete or Masonry >8" - solid precast or poured-in-place concrete, as well as concrete masonry units with grouted cells and actual thickness greater than 8".
- CMU <= 8" with Empty Cells - concrete masonry units (CMUs) with at least 50% of the CMU cells free of grout and actual thickness of 8" or less.
- CMU >8" with Empty Cells - CMUs with at least 50% of the CMU cells free of grout and actual thickness greater than 8".
- CMU <= 8" with Integral Insulation - CMUs with integral insulation (e.g., perlite or rigid insulation inserts within the cells of the concrete masonry units) and actual thickness of 8" or less.
- CMU >8" with Integral Insulation - CMUs with integral insulation (e.g., perlite or rigid insulation inserts within the cells of the concrete masonry units) and actual thickness greater than 8".

- *Other* - wall assemblies that do not fit in any of the other above-grade wall categories. You may also use the *Other* category if specific features of your wall give it a significantly lower U-factor than the corresponding generic wall type listed in the menu. See **Assembly U-Factor** under Exterior and Interior Wall Software Inputs.

Warning Note for Integral Insulation

Integral Insulation means insulation placed within the voids of CMUs. Selecting this wall type automatically gives you credit for integral insulation. Loose-fill insulation, such as perlite or rigid foam inserts are typically used. The *CMU with Integral Insulation* wall types assume loose-fill insulation. For walls with better performing integral insulation, use the *Other* wall category.

Do not enter values for *Cavity R-Value* and *Continuous R-Value* unless you have additional insulation attached to this CMU wall assembly. Alternatively, you may enter CMU walls using the *Other* wall type, but be prepared to provide supporting documentation for the U-factor that you are required to enter.

Do not confuse this Integral Insulation discussion with the "Integral" insulation position input available in ASHRAE's ENVSTD program. COM*check-EZ* does not provide an insulation position input but instead assumes an "integral" position for any insulation in above-grade exterior walls, as opposed to assuming the insulation is either on the interior or exterior of the wall. This fixed assumption provides the most generous assessment of the benefits of high heat-capacity walls that would have been available if COM*check-EZ* included a user-input for insulation position.

Exterior and Interior Wall Software Inputs

Gross Area or Perimeter

Enter the gross area of the wall component in the *Gross Area or Perimeter* field. The gross wall area includes the area of all windows and doors that penetrate the wall. Windows and doors appear below the wall to which they belong on the left side of the *Envelope* screen. To change the linkage of a window or door to a wall, drag the window or door label on the tree to the wall label and release the mouse. For interior walls, ignore all window and door assemblies that penetrate the wall.

Cavity Insulation R-Value

Enter the R-value of any insulation to be installed in the cavities between above-grade wall structural members. All R-values should be rated R-values for insulation materials, which are commonly printed on the materials. The insulating values of other parts of the building assemblies (e.g., gypsum board and air films) are already accounted for by the software based on assembly type.

Continuous Insulation R-Value

Enter the R-value of any continuous insulation in the above-grade wall. Continuous insulation is insulation that is continuous over framing members or furring strips and is free of significant thermal bridging. All R-values should be rated R-values for insulation materials. The insulating values of other parts of the building assemblies (e.g., gypsum board and air films) are already accounted for by the software based on assembly type.

Assembly U-Factor

If you have selected the *Other* wall type option, enter the overall U-factor of the above-grade wall assembly, including exterior and interior air films. Building departments may require supporting documentation for assemblies entered using the *Other* wall category and *U-Factor* field.

Furring Type

The *Furring* input field is displayed in the *Construction Details* column for structural masonry above-grade walls. The furring input enables you to specify the type of furring material (if any) used on the wall. If the wall has no furring, select *None*. If the wall assembly employs metallic furring strips, clips, or framing members, select *Metal*; otherwise, select *Wood*.

The furring material is assumed to create some thermal bridging of the insulation in the cavity between furring members, thereby reducing insulation effectiveness.

Heat Capacity

The *Heat Capacity* column is only displayed if an exterior wall or basement wall is created and the *Other* assembly type is selected. Heat capacity is the amount of heat (measured in Btus) necessary to raise the temperature of 1 ft^2 of wall 1°F. Allowable values are 1 to 25 Btu/(ft^2 °F), although no additional credit is given for heat capacity values greater than 21.

Example heat capacities for common wall constructions are shown below:

Wall Description	Heat Capacity
Typical wood- or steel-framed wall	2
2" brick face/framed wall	5
4" brick/framed wall	9
8" block w/empty cores	11
6" concrete wall	14
8" block w/solid-filled cores	16
12" block	15-18
Solid concrete/masonry wall greater than 8" thick	18-25

To precisely calculate the heat capacity of a wall assembly, sum the products of the thickness, density, and specific heat of each material layer. These properties for many common building materials can be found in Chapter 24 of the *1997 ASHRAE Handbook*

of Fundamentals. Because the specific heats of most building materials average around 0.2 Btu/(lb•°F), a good approximation of heat capacity for any wall assembly can be determined by estimating the weight per square foot of exterior wall surface and dividing by 5.

All COM*check-EZ* compliance calculations assume that any insulation in an above-grade exterior wall (or above-grade portion of a below-grade wall assembly) is integral with the thermal mass of the wall, as opposed to assuming the insulation is either on the exterior or the interior of the wall. This fixed assumption provides the most generous assessment of the benefits of high heat-capacity walls that would have been available had COM*check-EZ* included an insulation position input.

Interior Walls

Select the *Int. Wall* button to add an interior above-grade wall to the description of your design on the *Envelope* screen. Enter only interior walls separating conditioned from unconditioned space; ignore all other interior walls. Wall types for interior walls are the same as the wall types for exterior walls. The software inputs are also the same.

Basement Walls

The basement wall component is intended for use with walls that are either partially or fully below grade. Ignore portions of basement walls more than 10 ft below grade. The COM*check-EZ* software automatically treats above-grade portions of basement wall components like above-grade exterior walls.

Select the *Basement* button to add a basement wall component to the description of your design on the *Envelope* screen. Enter each unique basement wall assembly as a separate component. You can enter multiple basement wall elements sharing the same construction as one component with the appropriate total area.

Basement Wall Types

- *Solid Concrete or Masonry <= 8"* - poured-in-place concrete walls and concrete masonry units with grouted cells and actual thickness of 8" or less.
- *Solid Concrete or Masonry >8"* - poured-in-place concrete walls and concrete masonry units with grouted cells and actual thickness greater than 8".
- *CMU <= 8" with Empty Cells* - concrete masonry units with at least 50% of CMU cells free of grout and actual thickness of 8" or less.
- *CMU >8" with Empty Cells* - concrete masonry units with at least 50% of CMU cells free of grout and actual thickness greater than 8".
- *CMU <= 8" with Integral Insulation* - concrete masonry units with integral insulation (e.g., perlite or rigid insulation inserts within the cells of the concrete masonry units) and actual thickness of 8" or less.
- *CMU >8" with Integral Insulation* - concrete masonry units with integral insulation and actual thickness greater than 8".
- *Other* - wall assemblies that do not fit into any of the other basement wall categories. You may also use the *Other* category if specific features of your wall give it a significantly lower U-factor than the corresponding generic basement wall type listed in the menu. See **Assembly U-Factor** under Basement Wall Software Inputs.

Warning Note for Integral Insulation

Integral Insulation means insulation placed within the voids CMUs. Selecting this wall type automatically gives you credit for integral insulation. Loose-fill insulation, such as perlite or rigid foam inserts are typically used. The *CMU with Integral Insulation* wall types assume loose-fill insulation. For walls with better performing integral insulation, use the *Other* wall category. Alternatively, you may enter CMU walls using the *Other* wall type, but be prepared to provide supporting documentation for the U-factor that you are required to enter.

Basement Wall Software Inputs

Gross Area or Perimeter

Enter the gross area of the basement wall component in the *Gross Area or Perimeter* column. The gross wall area includes the area of both above-grade and below-grade portions of the basement wall, and all windows and doors that penetrate the wall. Windows and doors appear below the wall to which they belong on the tree on the left side of the *Envelope* screen. To change the linkage of a window or door to a basement wall, drag the window or door label on the tree to the basement wall label and release the mouse.

Windows and Doors in Basement Walls

When windows and doors are added to basement walls, net opaque wall areas are determined by subtracting windows and doors from any above-grade part of the basement wall. If necessary, the above-grade portion of the basement wall is increased so that windows and doors belong to the above-grade part of the basement wall. See *Wall Height* and *Depth Below Grade* Help topics for an explanation of how basement walls are treated with respect to being above or below grade.

Cavity Insulation R-Value

Enter the R-value of any insulation to be installed in the cavities between furring strips. All R-values should be rated R-values for insulation materials, which are commonly printed on the materials. The insulating values of other parts of the building assemblies (e.g., masonry and air films) are already accounted for by the software based on assembly type.

Continuous Insulation R-Value

Enter the R-value of any continuous insulation to be installed either on the inside or the outside of the basement wall. Continuous insulation is insulation that runs continuously and is free of significant thermal bridging. All R-values should be rated R-values for insulation materials. The insulating values of other parts of the building assemblies (e.g., masonry and air films) are already accounted for by the software based on assembly type.

Assembly U-Factor

If you have selected the *Other* basement wall type option, you must enter the overall U-factor of the basement wall assembly, including the interior air film but excluding the effects of earth and exterior air films. Building departments may require supporting documentation for assemblies entered using the *Other* basement wall category and *U-Factor* field.

Wall Height

Enter the average height of the basement wall measured from the top of the basement floor to the top of the basement wall.

The *Wall Height (ft)* and *Depth B.G. (ft)* fields together enable you to enter a basement wall assembly partially above and partially below grade as a single entry. If the values in these two fields are the same, the wall will be treated as entirely below grade.

Depth Below Grade

Enter the average depth below grade of the wall in the *Depth B.G. (ft)* field, measuring from the average grade level to the top of the basement floor.

Furring Type

The *Furring* input field (under *Construction Details*) enables you to specify the type of furring material (if any) used on the wall. If the wall has no furring, select *None*. If the wall assembly employs metallic furring strips, clips, or framing members, select *Metal*; otherwise, select *Wood*.

The furring material is assumed to create some thermal bridging of the insulation in the cavity between furring members, thereby reducing insulation effectiveness.

Entering Assemblies by Orientation

The software allows you to enter building components with or without considering the component orientation (north, south, east, and west). Initially, the orientation option is turned off. If you prefer to enter components based on their orientation, select the ***O****rientation* option under the ***O****ptions* menu. The compliance calculation will not be based on orientation-specific components until an orientation has been assigned to each exterior wall, window, door, and basement wall component.

If the orientation feature is not being used, you can group and list like components as a single component. However, if you need more than one entry of the same component (e.g. where two assemblies of the same type have different insulation levels), you must create as many additional components as required.

Daylight Control Factor

See *Daylight Control Factor* under *Options Menu*.

Doors

Select the *Door* button to add a door component to the description of your design on the *Envelope* screen. Enter each unique door assembly as a separate component. You can enter multiple door elements sharing the same characteristics as one component with the appropriate total area.

The *Door* button is intended for use with most types of commercial doors. Sliding-glass doors and atrium doors that function primarily as windows rather than to accommodate circulation (e.g., in multifamily or hotel/motel) should be entered using the *Window* button and not the *Door* button. Doors located in exterior walls and the walls of conditioned basements should be included, but areas of doors separating conditioned from unconditioned space should be included in the areas of the interior walls which they penetrate.

Door Types

- *Opaque* - exterior doors that are mostly opaque (i.e., glass covers less than half of the door's area) and are intended to accommodate occupant circulation.
- *Glass* - exterior doors that are mostly glazed (i.e., glass covers more than half of the door's area) and are intended to accommodate occupant circulation.
- *Overhead* - any large exterior doors designed to accommodate large objects and/or vehicular circulation.

- *Air Lock Entry* - exterior doors arranged in pairs to limit infiltration associated with occupant circulation.
- *Revolving* - revolving exterior doors such as those frequently used in hotels and large retail establishments.
- *Other* - any exterior doors that do not fit in any of the other five door categories. You must enter a U-factor and you should be prepared to provide the building department with manufacturers' literature or documentation of U-factor calculations.

Door Software Inputs

Gross Area or Perimeter

Enter the total area of the door in square feet, including any glazed portions. The rough opening for the door is an acceptable proxy for this door area.

U-Factor

Enter the overall U-factor for the door(s) from manufacturers' literature or select the ***U**se Typical* option from the pop-up context menu accessed by clicking the right mouse button in the *U-Factor* field. The ***U**se Typical* option provides a U-factor for a door judged typical of the selected type containing little or no thermal insulation.

Daylight Control Factor

See *Daylight Control Factor* under *Options Menu*.

Windows

Windows are defined as any transparent or translucent section in an exterior building wall, including sliding-glass doors, patio doors, and glass blocks but excluding glass entry doors (which are entered using the *Door* button). Windows include glazing material (which may be glass or plastic), framing (mullions, muntins, and dividers), external shading devices, internal shading devices, and integral (between glass) shading devices. Glazing having a slope greater than 60 degrees from horizontal is considered a window, while glazing having a slope less than 60 degrees from horizontal is considered a skylight.

Select the *Window* button to add a window component to the description of your design on the *Envelope* screen. Enter each unique window assembly as a separate component. You can enter multiple window elements having the same characteristics as one component with an appropriate total area.

Window Software Inputs

The software prompts you to enter three window characteristics each time you create a window component–frame type and glazing layers are entered in the *Assembly* column, and glazing type is entered under the *Construction Details* column. Specifying these window characteristics is helpful for inspection purposes and enables the software to provide typical performance characteristics (i.e., U-factor, SHGC, and VLT) for various glazing options.

Gross Area or Perimeter

Enter the area of the entire window component in square feet measured parallel to the window surface, including both glazed materials and frame. The rough window opening provides an acceptable proxy for this window area.

Frame Type and Glazing Layers

The frame type and glazing layers are selected from a pop-up list accessed by clicking the left mouse button in the *Assembly* field. The frame type enables you to identify the window frame material and hence characterize the thermal conductivity of the frame. For frame materials not listed, use the frame type that is thermally most similar; e.g., use *Wood* for metal-clad wood windows. The glazing layers enables you to identify the number of glazing layers in the windows (i.e., single, double, or triple). *Low-E* coatings are included in the list because the performance impact of low-emissivity films is similar to that of additional glass layers.

Glazing Type

The *Glazing* field (under *Construction Details*) enables you to identify the type of glass in the window (i.e., clear, tinted, or reflective). Use *Reflective* if the glass has a reflective surface, even if the glass is also tinted.

U-Factor

Window U-factor is based on the entire assembly, including both glazing and frame. Center-of-glass U-factors cannot be used. Glazing U-factors must be tested and documented by the manufacturer in accordance with the National Fenestration Rating Council (NFRC) test procedure. The COM*check-EZ* software includes a feature that enables you to insert a typical U-factor for the window characteristics you have selected. To access this feature, click the right mouse button on the U-factor input field and select *Use Typical*. The *Use Typical* feature provides values you can use in preliminary evaluations before selecting actual products. However, the actual ratings of products in the building must meet or exceed (i.e., be no higher than) the values you assume in the compliance analysis. Most products on the market will meet or exceed the performance levels provided by the *Use Typical* feature.

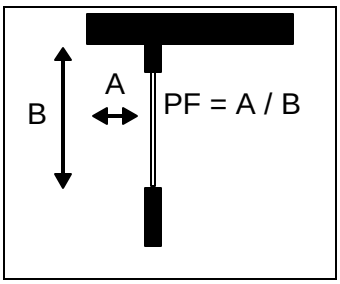
Solar Heat Gain Coefficient

The Solar Heat Gain Coefficient (SHGC) specifies the glazing's effectiveness in rejecting solar heat gain. SHGC is part of a system for rating window performance used by the NFRC. SHGC is gradually replacing the older index, shading coefficient (SC), in product literature and design standards. If you are using glass whose performance is listed in terms of SC, you may convert to SHGC by multiplying the SC value by 0.87.

SHGCs must be tested and documented by the manufacturer in accordance with the NFRC test procedure.

Projection Factor

The projection factor enables you to characterize the shading impact of horizontal overhangs or canopies that project outward from the plane of the window. The projection factor is the ratio of the distance the overhang projects from the window surface to its height above the sill of the window it shades. The software accepts values from 0.0 to 1.0.



Projection Factor

Daylight Control Factor

See *Daylight Control Factor* under *Options Menu*.

Visible Light Transmittance

See *Visible Light Transmittance* under *Options Menu*.

Skylights

Skylights are defined as any transparent or translucent section in a building roof, which include glazing material (glass or plastic), frame, and curb. Glazing having a slope less than 60 degrees from horizontal is considered a skylight, while glazing having a slope greater than 60 degrees from horizontal is considered a window.

Select the *Skylight* button to add a skylight component to the description of your design on the *Envelope* screen. Enter each unique skylight assembly as a separate component. You can enter multiple skylight elements having the same characteristics as one component with the appropriate total area.

Skylight Software Inputs

The software prompts you to enter three skylight characteristics each time you create a skylight component–frame type and glazing layers are entered in the *Assembly* column, and glazing type is entered under the *Construction Details* column. Specifying these skylight characteristics is helpful for inspection purposes and enables the software to provide typical performance characteristics (i.e., U-factor and SHGC) for various glazing options.

Gross Area or Perimeter

Enter the area of the entire skylight component in square feet measured parallel to the skylight surface, including both the glazing material and frame. The rough skylight opening provides an acceptable proxy for this skylight area.

Frame Type and Glazing Layers

The frame type and glazing layers are selected from a pop-up list accessed by clicking the left mouse button in the *Assembly* field. For frame materials not listed, use the frame type that is thermally most similar; e.g., use *Wood* for metal-clad wood skylights. The glazing layers field enables you to identify the number of glazing layers in the skylight (i.e., single, double, or triple). *Low-E* coatings are included in the list because the performance impact of low-emissivity films is similar to that of additional glass layers.

Glazing Type

The *Glazing* field (under *Construction Details*) enables you to identify the type of glass in the skylight (i.e., clear, tinted, or reflective). Use *Reflective* if the glass has a reflective surface, even if the glass is also tinted.

U-Factor

Skylight U-factor is based on the entire assembly, including glazing, sash, curbing, and other framing elements. Center-of-glass U-factors cannot be used.

U-factors for skylights must be tested and documented by the manufacturer in accordance with the NFRC test procedure. If an NFRC U-factor rating is available for your skylight, you should use its BB-Size rating (i.e., 48 by 48 in.).

The COM*check-EZ* program includes a feature that enables you to insert a typical U-factor for the skylight characteristics you have selected. To access this feature, click the right mouse button on the U-factor input field and select *Use Typical*. The *Use Typical* feature provides values you can use in preliminary evaluations before selecting

actual products. However, the actual ratings of products put in place in the building must meet or exceed (i.e., be no higher than) the values you assume in the compliance analysis. Most products on the market will meet or exceed the performance levels provided by the *Use Typical* feature.

Floors

Select the *Floor* button to add a floor component to the description of your design on the *Envelope* screen. Enter each unique exposed floor assembly as a separate component. You can enter multiple floor elements sharing the same construction as one component with the appropriate total area.

The *Floor* button is used to enter floors over unconditioned space, including floors exposed to exterior conditions, floors over crawl spaces, and floors over unconditioned parking garages. Interior floors that do not separate conditioned from unconditioned space are not included. Concrete slabs on grade are entered separately using the *Slab* button.

Floor Types

- *All-Wood Joist/Truss* - any structural wood floor in which insulation is placed between the structural members; e.g., batt insulation between wood floor joists.
- *Nonwood Joist/Truss* - any floor in which insulation is placed between nonwood structural members; e.g., batt insulation between steel bar joists or trusses with metal webs.
- *Structural Slab* - any floor structure in which floor is insulated primarily or exclusively using continuous-rigid or spray-on insulation.
- *Other* - floor assemblies that do not fit in any of the other three categories. See **Assembly U-Factor** under Floor Software Inputs.

Floor Software Inputs

Gross Area or Perimeter

Enter the gross area of the floor (in square feet) along the boundary where it separates conditioned from unconditioned space.

Cavity Insulation R-Value

Enter the R-value of any insulation to be installed in the cavities between floor structural members. All R-values should be rated R-values for insulation materials, which are commonly printed on the materials. The insulating values of other parts of the building assemblies (e.g., subfloor and air films) are already accounted for by the software.

Continuous Insulation R-Value

Enter the R-value of any continuous floor insulation. Continuous insulation is insulation that runs continuously over structural members and is free of significant thermal bridging. All R-values should be rated R-values for insulation materials. The insulating values of other parts of the building assemblies (e.g., subfloor and air films) are already accounted for by the software.

Assembly U-Factor

If you have selected the *Other* floor type option, you must enter the overall U-factor of the floor assembly, including exterior and interior air films. Building departments may

require supporting documentation for assemblies entered using the *Other* floor category and *U-Factor* field.

On-Grade Slabs

Slab-on-grade components include all concrete slabs whose perimeters are exposed to exterior conditions. Ignore slabs more than 2 ft below grade. Enter all exposed floors, including overhanging floors exposed to exterior conditions, floors over crawl spaces, and floors over unconditioned parking garages, as floor components rather than slab components.

Select the *Slab* button to add a concrete slab component to the description of your design on the *Envelope* screen. Enter each unique concrete slab/insulation combination (i.e., insulation R-value, position, and depth) separately. You can enter all slabs sharing the same insulation method as a single component with the appropriate total perimeter length.

Slab-on-Grade Software Inputs

Perimeter

Enter the perimeter of the on-grade slab component in linear feet in the *Gross Area or Perimeter* field.

Slab Type and Insulation Position

The slab type and insulation position are selected from a pop-up list accessed by clicking the left mouse button in the *Assembly* field. The slab type enables you to specify whether the concrete slab is heated or unheated. A heated slab (e.g., radiant slab) is one designed as part of a space-conditioning system for transmitting heating into the space. Heated slabs have higher insulation requirements than unheated slabs under the code.

The insulation position pop-up list enables you to specify if perimeter slab insulation will be used and, if so, if it will be placed vertically or horizontally. If no perimeter insulation will be used, select *No Insulation*.

Continuous Insulation R-Value

Enter the R-value of the slab perimeter insulation. If *No Insulation* has been selected from the *Assembly* pop-up list, the Cavity R-Value field will be disabled (gray).

Insulation Depth

The *Insul. Depth* field (under *Construction Details*) enables you to specify the depth of the insulation. If the insulation is placed vertically, insulation depth is measured from the top of the slab downward. If placed horizontally, insulation depth is the vertical distance from the top of the slab downward to the bottom slab, and then horizontally underneath the slab. Five options are available for horizontal insulation depth: *1', 2', 3', 4'*, and *Continuous*. Select *Continuous* if the insulation will run under the entire slab. Five options are also available for vertical insulation depth: *1', 2', 3', 4'*, and *>4'*. Where slab insulation is required, it must fully insulate the slab edge and extend from the top of the slab to the depth you select.

Lighting Screen

Use the blue-on-white buttons at the top of the *Lighting* screen to create a list of lighting fixtures present in your proposed design. Each fixture type you select is added to the lighting fixtures list displayed on the *Lighting* screen. For each fixture type, you must enter a ballast type (if applicable), the number of lamps per fixture, quantity, and the

fixture input wattage. Input wattage is the electrical power input to the lamp and ballast combination.

After entering complete information for each new fixture, the software automatically updates the compliance results. The results are displayed at the bottom of the screen in the *Lighting:* box. If *TBD* (to be determined) is displayed in this field, you most likely have not yet filled in the fixture wattage or quantity for one or more components. To determine which data are missing or invalid, look for fields with red-on-white text. In addition to providing inputs for all red-on-white fields, you must select at least one building use type and its corresponding area on the *Project* screen before the software can determine compliance.

Optional features available on the *Lighting* screen may be selected from the ***O**ptions* menu: Spaces (Lighting) and Exemptions and Allowances (Lighting).

T8/T12 Fluorescent

Select the *T8 / T12 Fluorescent* button to add fixtures using T8, T10, or T12 tubes to your list of fixtures on the *Lighting* screen.

Because of space limitations, lighting types are shown on the menus and main screen using abbreviations. For example, 48" T12 ES 34W stands for a fixture using 48" T-12 energy-saving fluorescent lamps rated at 34 watts each. The following abbreviations are used in these descriptions:

- ES – energy saving, a designation that usually indicates the lamp will draw 10% to 15% less power than a standard lamp of the same type
- Slim – slimline, a type of fluorescent lamp that uses single-pin contacts rather than the normal two-pin contacts
- T8 – a designation for tubular fluorescent lamps that are 1" in diameter
- T10 – a designation for tubular fluorescent lamps that are 1-1/4" in diameter
- T12 – a designation for tubular fluorescent lamps that are 1-1/2" in diameter
- U – U-shaped lamps
- W – nominal lamp wattage.

Compact Fluorescent

Select the *Compact Fluor.* button to add compact fluorescent fixtures to your list of fixtures on the *Lighting* screen.

Because of space limitations, lighting types are shown on the menus and main screen using abbreviations. For example, Twin Tube 13W stands for a fixture using compact fluorescent lamps rated at 13 watts each. The following abbreviations are used in the descriptions:

- Twin, Triple, Quad – designation referring to the number of fluorescent tubes projecting from the lamp (i.e., two, three, or four)
- 2-pin, 4-pin – designation referring to the number of contacts at the base of the lamp
- W – nominal lamp wattage.

HID

Select the *HID* button to add fixtures using high-intensity discharge (HID) lamps to your list of fixtures on the *Lighting* screen.

Incandescent

Select the *Incandescent* button to add fixtures using incandescent lamps to your list of fixtures on the *Lighting* screen.

Spaces

The *Lighting* screen contains an optional feature that enables you to organize lighting fixtures under the spaces (or parts of the building) in which they are used. To activate this feature, select *Spaces* from the *Options* menu while in the *Lighting* screen. This feature helps ensure fixture counts are correct and greatly facilitates plan review and inspections.

To add spaces to your list of lighting fixtures on the *Lighting* screen, click on the blue-on-white *Add Space* button (to the right of the fixture type buttons) at the top of the *Lighting* screen. A new line will be entered on the main portion of the *Lighting* screen and a new space label will appear in the tree control at the left of the screen. Fixtures listed below each space "belong" to that space and are listed that way on the compliance report. You can change the space name from the default name given by the software, which appears in the left-most table column. To reorganize fixtures under these space names, simply drag the fixture labels on the tree control.

Lighting Screen Inputs

Fixture ID

The *Fixture ID* field shows the fixture ID you have entered. You can associate the fixture with a fixture type designation used on the lighting fixture schedule and elsewhere in the construction documents; e.g., F1 for fixture type 1. *Fixture ID* is an optional field that you may leave blank, but it is recommended as it enables fixtures to be clearly defined.

Fixture Description

The *Fixture Description* field is for descriptions of fixtures that you enter. *Fixture Description* is an optional field that you may leave blank. However, fixture descriptions can help you keep track of the fixtures in the list, avoid errors and oversights, and facilitate plan review and inspections because this information is included on the compliance report. Fixture descriptions may include manufacturer and part number, dimensions (e.g., 2x4), mounting type (e.g., recessed, surface, suspended), or other distinguishing characteristics.

Lamp Description/Wattage Per Lamp

Click the left mouse button in the *Lamp Description/Wattage Per Lamp* field to select from a pop-up list of available lamp types. The pop-up list contains the most commonly used lamp and ballast combinations. Select *Other* if the lamp type you intend to use does not match one of the listed types. The *Lamp Description/Wattage Per Lamp* is not a user-editable field unless you have selected *Other* from the pop-up list.

Ballast

The ballast type is entered by selecting from a pop-up list. (Incandescent fixtures do not require a ballast entry). Available ballast types are magnetic and electronic, and hybrid.

The following definitions have been used in determining default input wattages. You should use these definitions in describing the ballast type in the fixtures you intend to use.

- Magnetic – contains conventional capacitor, rectifier, and/or transformer components (core and coil), and operates at a 60 Hz frequency.
- Electronic – contains advanced electronic components and no (or very small) core and coil transformers, and operates at high frequency-typically 20,000 Hz or more.
- Hybrid – may contain both conventional components and electronic circuitry. Use *hybrid* for any ballast that does not completely fit the definition for either magnetic ballasts or electronic ballasts.

Lamps Per Fixture

The *Lamps Per Fixture* is entered by selecting from a pop-up list.

Fixture Wattage

You can enter the fixture wattage directly or have the software provide a typical wattage for that fixture. To input a typical wattage, click the right mouse button in the *Fixture Wattage* field to display the pop-up context menu. The software will provide a typical input wattage for the fixture. Not all possible lamp and ballast combinations are included-only those for which adequate data were available. No values are provided for fixtures with hybrid ballasts, because the category includes equipment of highly variable design. If the ***U****se Typical* option is gray, a typical wattage is not available. Input wattage is the related electrical power input to the lamp and ballast combination.

You may either use the typical input wattage provided by the software or override it with a value based on the equipment you intend to install. In either case, you should be prepared to provide supporting documentation based on manufacturer's literature to the building department.

Mechanical Screen

Use the blue-on-white buttons at the top of the *Mechanical* screen to enter characteristics of HVAC system, plant, and water-heating components in your proposed design. Because most requirements in the mechanical section of the energy code are mandatory, the *Mechanical* section of the software works somewhat differently from the *Envelope* and *Lighting* sections. Rather than generating a numerical compliance index, the *Mechanical* section generates a customized list of mandatory requirements applicable to the mechanical components you identify.

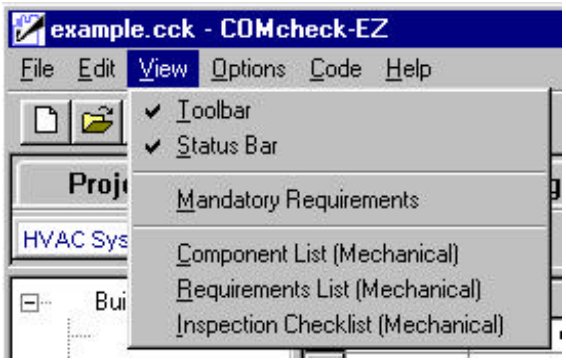
Click the *Plant* button or *Water Heating* button to display a single screen on which you enter information about these components. Click the *HVAC System* button to launch a series of screens (collectively referred to as a wizard) on which you enter information about your building's HVAC components. The HVAC system wizard screen sequences depend on the information you enter. You must continue to the final screen in the sequence before the *Finish* button becomes active, enabling you to return to the *Mechanical* screen.

After you click the *Finish* button on any of the screens, the software supplies a default component name (in the left-hand screen), along with a corresponding quantity and description (in the right-hand screen) for the component you defined. You can edit the default component description or quantity by simply clicking on the appropriate field and typing a new description or quantity. For clarity and consistency with building plans, it may also be helpful to edit the tree labels in the left-hand screen. To change these default names, double-click on the name in the left-hand screen to bring up an edit box for the

text. Alternatively, you can right-click on the name to display a pop-up list (called a context menu) and select *Edit Text* from this menu. Selecting *Edit System Inputs, Edit Plant Inputs, or Edit SWH Inputs* from the context menu enables you to redisplay the input screens for the given component and to redefine the component inputs. You may also delete (cut), copy and paste, or duplicate components by selecting the corresponding option from the context menu. For more information on context menus, refer to the Help section *Context Menu*.

Viewing Mechanical Requirements

To view the requirements that apply to a mechanical component, select the component, then go to the ***V**iew* menu and click the *Requirements List* or *Inspection Checklist* option. The *Requirements List* option displays a comprehensive description of requirements applicable to the selected component. The *Inspection Checklist* option displays the same requirements, but in an abbreviated (checklist) format. You can use the ***V**iew* menu to toggle the display back to the list of mechanical components or to the detailed or concise list of requirements. The output report will contain all three views: the list of your selected mechanical components, the checklist of requirements, and the more detailed description of these same requirements.



View Menu - Mechanical

While in the *Requirements List* or *Inspection Checklist* view, click the *Building* label on the left-hand screen to display mechanical requirements that apply to all applicable building systems, independent of particular components selected. Even though these requirements apply to all applicable systems, the same list of requirements may not always be displayed. For example, there are duct insulation and construction requirements that apply to all systems that have ducts. Rather than repeat these same requirements for each ducted system in the building, the requirements are printed once as generic requirements and are displayed when the *Building* label is selected. However, if you have not selected any systems having ducts, the requirements will not be displayed. Other requirements will always appear. You can also find a description of the generic requirements by selecting *Mandatory Requirements* from the ***V**iew* menu.

To view an example description of mechanical components, load the EXAMPLE file from the ***F**ile* menu and click the *Mechanical* screen. To view the Mechanical Compliance Report from within the software, select *Print Preview* from the ***F**ile* menu. The checklist portion of the compliance report is intended for use by building department staff during plan review and site inspection to ensure that applicable requirements have been met.

HVAC System Screens

The *HVAC System* button launches a sequence of screens to help you identify key characteristics of the HVAC systems in your building. The term HVAC systems refers to secondary HVAC systems, including controls, fans, terminal boxes, radiators, coils, and package HVAC equipment, not primary HVAC system components such as boilers, chillers, cooling towers, and pumps. The characteristics you select determine which requirements apply.

The HVAC System screens enable you to describe the HVAC system features in your building in sufficient detail to exclude large numbers of requirements that do not apply to your systems. The resulting simplification facilitates both designing for compliance with the code and code enforcement.

Round buttons (radio buttons) permit only one selection from each group, square boxes (checkboxes) permit multiple selections from a group of inputs, and gray text indicates that the option is unavailable because it is incompatible with other selection(s) that have been made on the current or a previous screen.

When multiple different HVAC systems are used within a single building, you may select the *HVAC System* button multiple times to enter more than one system. When multiple identical (or nearly identical) systems are used, describe them once and use the quantity field to indicate the number of such systems present.

Equipment Type Selection Screen

The *Equipment Type Selection* screen is the first in a series of screens that enable you to enter characteristics of the HVAC system(s) in your proposed design. Select the *Heating Equipment Type*, *Cooling Equipment Type,* and *Zoning Category* for the system(s) you are entering.

Note that some of the input fields are interdependent. If you select *Heat Pump* as the *Heating Equipment Type*, you will not be able to select a *Cooling Equipment Type* because it is assumed to be DX (direct expansion). If you select *Unit Heater* for *Heating Equipment Type* or *Packaged Terminal DX Unit* for *Cooling Equipment Type*, you will not be able to select *Multiple-Zone* or check the *Perimeter System* box under *Zoning Category* because these equipment types are not compatible.

After entering all your selections on the *Equipment Type Selection* screen, click the *Next* button to proceed to the next screen and continue describing the mechanical system.

Heating Equipment Type

Central Furnace - A central furnace is a self-contained, indirect-fired or electrically heated furnace supplying heated air through ducts to spaces. A central furnace can be a stand-alone unit, but is typically integral to a rooftop-DX (direct expansion) system or split DX system air conditioner. Though less common, a central furnace may also contain a hydronic coil that would be used for air conditioning.

Duct Furnace - A duct furnace is a furnace normally installed in distribution ducts of air-conditioning systems to supply warm air. A duct furnace usually does not have its own supply fan and uses air supplied through the ducts by other supply fans such as a fan for a central air conditioner.

Hydronic or Steam Coil - A hydronic coil is an array of tubing, placed in a supply air stream, through which hot or cold water passes, heating or cooling the supply air stream to provide heating or air conditioning to a space. Hydronic coils, central furnaces, and DX coils are used in various configurations of heating and air- conditioning systems. A

steam coil is an array of tubing, placed in a supply air stream, through which steam passes to provide heat to a space.

Heat Pump - A heat pump is a DX air conditioner with a reversing valve, allowing it to operate in two refrigeration modes. When the refrigeration system is reversed, the heat pump absorbs heat from the outdoor air and rejects it to the indoor environment, providing heat to the space. Heat pumps are manufactured in several configurations, including packaged terminal, rooftop package, split system, water loop, and ground coupled.

Radiant Heater - A radiant heater is a heater that transfers heat to objects and surfaces within the heated space primarily (greater than 50%) by infrared radiation. Radiant heaters can be direct- or indirect-fired with a heating fuel, have electric heating elements, or use hydronic coils or steam coils.

Unit Heater - A unit heater is a self-contained piece of heating equipment that requires connections only to energy sources. Unit heaters are installed in the spaces they are intended to heat and do not use ductwork to distribute heat. They are sometimes controlled in sequence with a separate air conditioner serving the same space. Unit heaters can be direct- or indirect-fired with a heating fuel, have electric heating elements, or use hydronic coils or steam coils.

Cooling Equipment Type

Field Assembled DX System – This type is used for DX systems that are not manufactured (and rated) as single packages but rather are assembled at the building site from separately manufactured components. DX stands for direct expansion cooling. In DX cooling equipment, a refrigerant coil is placed directly in the supply air stream. As the refrigerant evaporates and expands, it removes energy, lowering the temperature of the supply air stream.

Hydronic Coil - A hydronic coil is an array of tubing, placed in a supply air stream, through which hot or cold water passes, heating or cooling the supply air stream to provide heating or air conditioning to a space. Hydronic coils, central furnaces, and DX coils are used in various configurations of heating and air-conditioning systems.

Packaged Terminal DX Unit – A packaged terminal DX air conditioner (PTAC) is a self-contained air-conditioning unit typically installed through a wall. It discharges cool air directly to the space without the use of ducts for distribution. PTACs are often equipped with electric resistance heating elements and sometimes are equipped with hydronic coils or steam coils for heating.

Rooftop Packaged DX Unit – A rooftop packaged DX unit is also known as a unitary single-packaged air conditioner. This unit is a self-contained DX air conditioner, typically installed on the roof of a building using ducts to distribute cool air to the conditioned space. It can be used in single-zone or multiple-zone applications, and can also be equipped with a constant-volume or variable-volume fan. These units are often combined, within the same assembly, with a central furnace, hydronic coils, or steam coils. Depending on the cooling capacity and climate, rooftop packaged DX units may often be equipped with an air economizer.

Split DX System – A split DX system is also known as a unitary split system air conditioner or split system. It consists of two factory-made assemblies: a condensing unit that uses outside air as the heat sink, and an indoor DX coil with integral supply fan. The indoor unit is often combined, within the same assembly, with a central furnace or hydronic coils or steam coils. Because the indoor unit is usually located a long distance from outside walls, it is difficult to equip a split system with an air economizer.

Zoning Category

Single Zone – A single-zone system serves only one thermostatic control zone. The system is usually controlled by a single thermostatic control, and only maintains comfort conditions for the space where the temperature control is located.

Multiple-Zone – A multiple-zone system is designed to meet space-conditioning loads in multiple thermostatic control zones at the same time. Multiple-zone systems usually use a common air distribution system and employ terminal units to vary the flow and temperature of air to meet the differing space-conditioning loads of each zone.

Perimeter System – A perimeter system is designed to offset only envelope heat losses and gains.

Heating Equipment Details Screen

The *Heating Equipment Details* screen is the second in a series of screens that enables you to enter characteristics of the HVAC systems in your proposed design. This screen will appear if you have selected any heating equipment other than *Heat Pump* in the *Equipment Type Selection* screen.

Select the *Fuel Type* or the *Heat Source* for the heating equipment. If you select *Hydronic or Steam Coil* as the *Heating Equipment Type*, all selections for *Fuel Type* will be disabled and you instead must select the *Heat Source* for this equipment. If you select *Central Furnace* or *Duct Furnace*, all selections for *Heat Source* will be disabled. If you select *Radiant Heater* or *Unit Heater*, you may choose from either the *Fuel Type* or *Heat Source* options.

When you have finished your selections on the *Heating Equipment Details* screen, click the *Next* button to proceed to the next screen and continue describing the mechanical system, or click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. If additional screens must be completed, the *Next* button will be enabled (black text) and the *Finish* button will be disabled (gray text). If there are no additional screens, the *Next* button will be disabled and the *Finish* button will be enabled. You may cancel the sequence of selections you have made at any time by pressing the **Esc** (escape) key.

Heat Pump Details Screen

The *Heat Pump Details* screen will be the second in a series of screens that enable you to enter characteristics of the HVAC systems in your proposed design. This screen will appear if you have selected *Heat Pump* as the *Heating Equipment Type* in the first screen. Select the *Heat Pump Type, Condenser Type* and *Capacity*. Note that *Water-Cooled* is the only condenser option available if *Water Loop Heat Pump* is selected as the *Heat Pump Type*.

When you have finished your selections on the *Heat Pump Details* screen, click the *Next* button to proceed to the next screen or click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. You may cancel the sequence of selections you have made at any time by pressing the **Esc** (escape) key.

Heat Pump Type

Packaged Terminal Unit – A packaged terminal heat pump (PTHP) is a self-contained heat pump typically installed through a wall. It discharges warm or cool air directly to the space without the use of ducts for distribution.

Rooftop Packaged Unit – A rooftop packaged heat pump is also known as a unitary single-packaged heat pump. This unit is a self-contained heat pump, typically installed on the roof of a building using ducts to distribute cool air to the conditioned space. It can

be used in single-zone and multiple-zone applications, and can also be equipped with a constant-volume or variable-volume fan. Depending on the cooling capacity and climate, rooftop packaged DX units may be equipped with an air economizer.

Split System – A split system heat pump is also known as a unitary split system heat pump. It consists of two factory-made assemblies: a condensing unit that uses outside air as the heat sink (during cooling) and heat source (during heating), and an indoor DX coil with integral supply fan. Because the indoor unit is usually located a long distance from outside walls, it is difficult to equip a split system with an air economizer.

Water Loop Heat Pump – A water loop heat pump is a heat pump with a refrigerant-to-water heat exchanger. During cooling mode, the heat exchanger serves as the condenser, rejecting heat from the refrigerant to the water. During heating, the heat exchanger serves as the evaporator, absorbing heat from the water. The refrigerant-to-water heat exchanger is typically connected to a circulating water loop that also serves many other water loop heat pumps. A boiler and cooling tower maintain the temperature range of the circulating water loop. The boiler turns on when the temperature falls below the set point. The cooling tower turns on when the temperature rises above the set point.

Other – Any type of heat pump, which is not described by one of the types listed above, is classified as *Other*.

Condenser Type

The condenser of an air conditioner is where refrigerant rejects heat absorbed during the process of cooling indoor spaces. As the refrigerant passes through the heat exchanger it rejects heat to the surrounding fluid, usually air or water. If the equipment is a heat pump, the condenser becomes an evaporator during heating mode. As the refrigerant passes through the heat exchanger, it absorbs heat from the surrounding fluid, causing the refrigerant to change from a liquid to a gas (or evaporate).

Air-Cooled – An air-cooled condenser is a refrigerant-to-air heat exchanger exposed to outdoor conditions. As refrigerant passes through the coils of the heat exchanger, heat is rejected to outdoor air (during cooling) and absorbed from outdoor air (during heating).

Evaporatively Cooled – An evaporatively-cooled condenser is similar to an air-cooled condenser with the exception that during cooling, the heat exchanger is sprayed with water, increasing the heat rejection. Heat pumps and air conditioners equipped with evaporatively cooled condensers are typically more efficient than their air-cooled counterparts.

Groundwater Coupled – A groundwater-coupled condenser is similar to a water-cooled condenser except that groundwater will always be the heat source (or sink) for the condenser. As refrigerant passes through the coils of the heat exchanger, heat is rejected to groundwater (during cooling) and absorbed from groundwater (during heating).

Water-Cooled – A water-cooled condenser is a refrigerant-to-water heat exchanger. As refrigerant passes through the coils of the heat exchanger, heat is rejected to the water (during cooling) and absorbed from the water (during heating). Heat pumps with water-cooled condensers are typically connected to a central circulating water loop with other water loop heat pumps.

Capacity

Select the cooling capacity range for the heat pump.

Multiple-Zone Details Screen

The *Multiple-Zone Details* screen will only appear if you have selected *Multiple-Zone* for the *Zoning Category* on the first screen. Select the *Distribution Type*, *Terminal Unit Type* (if applicable), and *Reheat Type* (if applicable).

Note that some of the input fields are interdependent. If you select *Single Duct* as the *Distribution Type*, you will not be able to select *VAV Mixing Box* or *CV Mixing Box* for *Terminal Unit Type*, because they are only applicable to dual-duct systems. If you select *Three Duct* as the *Distribution Type*, *Terminal Unit Type* options and *Reheat Type* options will be disabled, because they are not applicable to this distribution type.

When you have finished your selections on the *Multiple-Zone Details* screen, click the *Next* button to proceed to the next screen and continue describing the mechanical system.

Distribution Type

Single Duct – Single-duct systems are the most common types of multiple-zone air distribution systems. A single-duct system uses a single fan to supply cool or warm air to zone terminal units. The zone terminal units will then modulate the amount of supply air and sometimes reheat the supply air to meet the specific heating or cooling requirements of the zone. Some systems will recool the supply air, but reheating is more standard practice.

Single Fan, Dual Duct – A single-fan, dual-duct system uses a single fan to supply air through two primary air ducts, supplying cool air and warm air. Air from each of these ducts is then mixed in a terminal unit (VAV mixing box or CV mixing box) and supplied to the zone as a single air stream.

Dual Fan, Dual Duct – A dual-fan, dual-duct system uses two fans to supply air through two primary air ducts, supplying cool air and warm air. One fan serves the warm air duct, and the other serves the cool air duct. Air from each of these ducts is then mixed in a terminal unit (VAV mixing box or CV mixing box) and supplied to the zone as a single air stream.

Three Duct – A three-duct system uses a single fan to supply three primary air ducts, supplying cool air, warm air and return (or neutral) air. A three-duct system is typically constant volume and uses CV mixing boxes to mix warm air and return air or cool air and return air (but never warm and cool air) to meet individual zone loads.

Terminal Unit Type

VAV Box – A standard VAV box includes a damper, a connection to the supply air duct, and sometimes a hydronic or electric resistance reheat coil. Because the zone thermostat calls for less cooling, the damper begins to close and reduce the amount of supply air to the zone. The reheat coil turns on and reheats the supply air only when the damper is at its minimum position. Standard VAV boxes are used in both single-duct and dual-duct systems.

Fan-Powered VAV Box – A fan-powered VAV box typically consists of a fan configured to draw air from a return air plenum, a connection to the supply air duct, dampers to regulate the flow of air from the supply air duct and the flow of air from the plenum to the fan, and a hydronic or electric resistance reheating coil. There are many configurations of fan-powered VAV boxes, but there are only two typical operation sequences: series and parallel.

In series operation, the fan operates continuously, resulting in a constant air supply to the zone. As the zone thermostat calls for less cooling, the dampers modulate to reduce the amount of supply air and increase the amount of plenum air delivered to the zone. The

reheat coil turns on and reheats the supply air only when the damper is at its minimum position.

In parallel operation, the fan does not operate as long as the zone calls for cooling. If the main supply air is reduced to a minimum and the zone still requires heating, the fan will come on, supplying additional warmer plenum air to the zone. If the zone requires additional heating after the fan has come on, the reheat coil is activated.

VAV Mixing Box – A VAV mixing box mixes air from the warm and cool air ducts of a dual-duct system. The operation sequence of a mixing box terminal depends on several other conditions such as if the air economizer is operating or if the building is primarily requiring cooling or heating.

If an air economizer or the mechanical cooling plant is operating, the warm air supply to the zones is shut off by the mixing boxes. The mixing box modulates the flow of cool air to the zone to meet the required space conditioning. When the cool air damper has closed to its minimum position, the mixing box will then modulate open to allow warm air to be mixed with the cool air and simultaneous heating and cooling begins. At some point, the mixing box may completely close the cool air supply to the zone. Care must be taken when controlling mixing boxes to ensure that supply air is never completely shut off to a zone. This would prevent adequate outdoor ventilation air from being supplied to the space.

In some cases an entire building may be in heating mode, beyond what can be met by unheated return air alone. In this case, the mixing boxes will shut off the supply of cool air to the zones. The mixing box modulates the flow of warm air to the zone to meet the required space conditioning. When the warm air damper has shut to its minimum position, the mixing box will modulate open to allow cool air to be mixed with the warm air. Like in the primary cooling mode, the warm air damper may totally close at some point, but supply air to the zone must never be completely shut off.

CV Mixing Box – A CV mixing box (or constant-volume mixing box) mixes necessary amounts of cool air and warm air to maintain space conditions. The amount of cool air or warm air will vary, but the total flow of cool and warm air through a CV mixing box will remain constant. Except under special conditions, the code does not allow the use of CV mixing boxes.

Reheat/Recool Coil – A reheat/recool coil is placed in a branch line to a zone of a building and is usually controlled from a thermostat located in the space the branch is serving. Reheat/recool coils are usually found only in single-duct VAV systems. For example, if a reheat coil is installed in a duct, it would provide heating to a zone if the system were in cooling mode and supplying cool air through the distribution system. Reheat coils can be electric resistance elements, hydronic coils, or steam coils. Recool coils are not very common and are almost always hydronic. (COM*check-EZ* assumes recool coils are hydronic.)

Reheat Type

Electricity – When *Electricity* is used as the reheat type, electric resistance heating elements are installed in the terminal units and are turned on and off by zone thermostatic controls.

Hydronic – Hot water coils are hydronic coils installed in the terminal units. They are equipped with valves, which modulate the flow of hot water, and are controlled by zone thermostatic controls.

Steam – Steam coils, used as a reheat source, are installed in terminal units. They are equipped with valves, which modulate the flow of steam, and are controlled by zone thermostatic controls.

Fan System Details Screen

The *Fan System Details* screen will only appear if you have selected *Multiple-Zone* for the *Zoning Category* on the first screen. Check the applicable boxes under *Fan System Details.* If you select *Supply Fan HP >25 hp* or *Return Fan HP >25 hp*, select the *Fan Variable Flow Control* on your system. If you only select *Supply Static Pressure >3 in. water*, the *Fan Variable Flow Control* options are disabled.

When you have finished your selections on the *Fan System Details* screen, click the *Next* button to proceed to the next screen in the series or click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. You may cancel the sequence of selections you have made at any time by pressing the **Esc** (escape) key.

Fan System Details

Supply Fan HP >25 hp – The supply fan hp is the horsepower listed on the supply fan motor nameplate. The supply fan is the fan that provides air to the distribution ducts of the mechanical system. Select this option if the listed horsepower is greater than 25 hp.

Supply Static Pressure >3 in. water – Static pressure is the total amount of pressure exerted by the supply or return air stream on the ductwork. In air distribution and return systems, this pressure is measured in inches of water column (in. water). Most large supply air distribution systems and multiple-zone systems operate at static pressures exceeding 3 in. water. Occasionally, static pressure in return air systems exceeds 3 in. water, in which case this option should be selected.

Return Fan HP >25 hp - The return fan hp is the horsepower listed on the return fan motor nameplate. Select this option if the return fan horsepower exceeds 25 hp.

Fan Variable Flow Control

Vane-Axial Fan w/Variable Pitch Blades – A vane axial fan resembles a propeller. When equipped with variable pitch blades, the blades are rotated or twisted (thus varying the pitch of the blades) to modulate the air flow from the fan.

Mechanical Adjustable-Speed Drive – A mechanical adjustable-speed drive uses mechanical devices to vary the speed of the fan–and therefore vary the flow of air– without varying the speed of the fan motor. One of the most common approaches is to vary the diameter of the shieves in the belt-drive.

Electrical Adjustable-Speed Drive - An electrical adjustable-speed drive is an electrical control system that will vary the speed of the fan motor, which will vary the flow of air. The most common type of electrical adjustable speed drive is the variable-frequency drive (VFD). A VFD is usually the most efficient approach to varying air flow from a fan.

Other Control – Many different types of fan air flow controls are available. Designers must use a combination of calculations, manufacturer's literature, and actual design conditions to determine the energy performance of different fan air flow controls.

Cooling Equipment Details Screen

The *Cooling Equipment Details* screen will appear if you have selected any of the *Cooling Equipment Type* options on the first screen other than *None*.

Select the *Condenser Type* and the *Capacity* range.

When you have finished your selections on the *Cooling Equipment Details* screen, click the *Next* button to proceed to the next screen in the series, or click the *Finish* button (if not grayed out) to accept all of the inputs and return to the *Mechanical* screen. You may

cancel the sequence of selections you have made at any time by pressing the **Esc** (escape) key.

Condenser Type

The condenser of an air conditioner is where refrigerant rejects heat absorbed during the process of cooling indoor spaces. As the refrigerant passes through the heat exchanger, it rejects heat to the surrounding fluid, usually air or water.

Air-Cooled – An air-cooled condenser is a refrigerant-to-air heat exchanger exposed to outdoor conditions. As refrigerant passes through the coils of the heat exchanger, heat is rejected to outdoor air (during cooling) and absorbed from outdoor air (during heating).

Evaporatively Cooled – An evaporatively-cooled condenser is similar to an air-cooled condenser with the exception that during cooling, the heat exchanger is sprayed with water, increasing heat rejection. Heat pumps and air conditioners equipped with evaporatively-cooled condensers are typically more efficient than their air-cooled counterparts.

Water-Cooled – A water-cooled condenser is a refrigerant-to-water heat exchanger. As refrigerant passes through the coils of the heat exchanger, heat is rejected to the water (during cooling) and absorbed from the water (during heating). Heat pumps with water-cooled condensers are typically connected to a central circulating water loop with other water loop heat pumps.

Capacity

Select the cooling capacity range for the cooling equipment selected on the first screen.

Economizer Details Screen

The *Economizer Details* screen will appear if the building location entered in the *Project* screen is located within a climate zone requiring an air economizer. The *Economizer Details* screen will not appear if:

- your building is located in climate zones 1, 2, or 3b; or
- the cooling capacity for the mechanical system is less than 90 kBtu/h.

Select the *Economizer Type*. If you do not have an economizer, select *None* for the *Economizer Type* and choose an *Economizer Exception*.

The input fields have the following interdependencies:

- Air economizers are not allowed if you selected *Single Fan*, *Dual Duct*, or *Three Duct* as the *Distribution Type* on the *Multiple-Zone Details* screen. An air economizer is not allowed with these system types.
- If you selected the *Water-Cooled* condenser, you will not be able to select *Filtration Requirements* or *Open Case Refrigeration* as an economizer exception.
- You will not be able to select *High Efficiency Equipment* as an *Economizer Exception* in climate zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15, 16, 17, 18, or 19.

When you have finished your selections on the *Cooling Equipment Details* screen, click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. You may cancel the sequence of selections you have made at any time by pressing the **Esc** (escape) key.

Economizer Type

Air - An air economizer consists of a set of interlocked dampers on return air, exhaust air, and outside air ducts. During favorable weather conditions, the air economizer is controlled to use up to 100% outside air to cool the space instead of using mechanical refrigeration.

Water – A water economizer is a system by which the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling. Typically, water is first passed through a cooling tower, then through a hydronic coil in the supply air stream.

None – Select this option if an economizer will not be installed. Selecting this option will activate some or all of the *Economizer Exception* options. The *High Efficiency Equipment* exception will only be activated if the building resides in a climate zone for which the exception is allowed.

Economizer Exception

High Efficiency Equipment – In some cases, a high-efficiency air conditioner may use no more cooling energy than an air conditioner equipped with an air economizer that just meets the requirements. In these cases, the economizer may be omitted. The efficiency required to take this exception will be included in the requirements list.

Open Case Refrigeration – Air economizers can adversely affect the operation of open case refrigeration equipment such as that used in grocery stores to display refrigerated and frozen foods. This exception is not available if the cooling equipment has a water-cooled condenser, where a water economizer would be feasible.

Filtration Requirements – In some cases, unusual outdoor air pollutants necessitate extensive filtration of outdoor air. When an air economizer is installed, filtration equipment must be capable of purifying 100% outdoor air supply and would be prohibitively expensive. This exception is not available if the cooling equipment has a water-cooled condenser, where a water economizer would be feasible.

Plant Screen

The *Plant* button displays a screen that enables you to identify key characteristics of the plant equipment in your building. The term, "*Plant,*" refers to primary HVAC system components, including boilers, chillers, cooling towers, and pumps; not secondary HVAC system components such as fans, terminal boxes, radiators, coils, and package HVAC equipment.

The *Plant* screen allows you to describe the features of the building's plant(s) in sufficient detail to exclude requirements that do not apply to your building. The resulting simplification helps in designing the building to comply with the code and in code enforcement.

Round buttons (radio buttons) permit only one selection from each group.

Where multiple different HVAC plant components are present within the building, you may select the *Plant* button multiple times to enter more than one component. Where multiple identical (or nearly identical) plants are present, describe them once and use the *Quantity* field to indicate the number present.

Plant Equipment Details Screen

The *Plant Equipment Details* screen allows you to describe your central heating plant or central cooling plant. To enter a boiler, select a *Boiler Type, Heating Capacity Range,* and *Boiler Fuel.* To enter a chiller or condensing unit, select a *Cooling Plant Type, Condenser Type,* and *Cooling Capacity Range.*

When you have finished your selections on the *Cooling Equipment Details* screen, click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. You may cancel your selections by pressing the **Esc** (escape) key.

Boiler Type

Hot Water – Select this option if the central boiler is a hot water boiler.

Steam – Select this option if the central boiler is a steam boiler.

None – Select this option if you are describing a cooling plant instead of a central boiler.

Boiler Fuel

Gas – Select *Gas* if the boiler uses natural gas or propane.

Oil – Select *Oil* if the boiler uses new heating oil that has not been recycled or re-refined.

Residual Oil – Residual oil is fuel oil that remains after the removal of valuable distillates (such as gasoline) from petroleum and is used most often in industrial applications.

Heating Capacity Range

Select the heating capacity range for the boiler.

Cooling Plant Type

Condensing Unit – A condensing unit is the refrigeration system component that includes the refrigerant compressor and the condenser. Refrigerant lines are installed between the condensing unit and a refrigerant-to-water heat exchanger (creating a field-fabricated water chiller) or to a DX coil (creating a field-fabricated DX system).

Water Chiller – A water chiller is a self-contained piece of cooling equipment including, at a minimum, a refrigerant-to-water heat exchanger and a refrigeration compressor. Water is cooled in the refrigerant-to-water heat exchanger and piped to air handlers used for air conditioning throughout a building. Most water chillers include a water-cooled, air-cooled, or evaporatively-cooled condenser; however, some water chillers are manufactured without condensers.

Cooling Capacity Range

Select the cooling capacity range for the condensing unit or chiller. Ranges for condensing units are given in kBtu/h. Ranges for chillers are given in tons.

Service Water Heating Screen

The *Water Heating* button displays a screen that enables you to select two characteristics of the service water heating system(s) in your building. The selection (or deselection) of the two checkboxes on the *Service Water Heating Details* screen determines which water heating requirements apply to your building.

Where multiple different water heating systems are present within the building, you may select the *Water Heating* button multiple times to enter more than one system. Where

multiple identical (or nearly identical) systems are present, describe them once and use the quantity field to indicate the number present.

Service Water Heating Details Screen

The *Service Water Heating Details* screen allows you to provide basic information about your service water heating system. Checkboxes are provided for indicating whether or not your system has a circulation pump and/or if heat trace tape is installed.

When you have finished your selections on the *Service Water Heating Details* screen, click the *Finish* button to accept all of the inputs and return to the *Mechanical* screen. You may cancel your selections by pressing the **Esc** (escape) key.

System Details

System Has a Circulation Pump - A circulation pump is used in a service water heating system served by a continuous water loop. The circulation pump is controlled to circulate hot water from the water heating equipment as necessary to maintain a certain hot water temperature at all times in the circulation loop.

Heat Trace Tape Installed in the System - Heat trace tape is tape with embedded electric resistance heating elements. Heat trace tape is adhered to hot water piping. It is energized as necessary to deliver hot water at the desired temperature.

Building Use Types

The *Whole Building* types and the *Area Categories* available in the software are defined below.

Whole Building Types

Assembly – A building or structure for the gathering together of persons, such as auditoriums, churches, dance halls, gymnasiums, theaters, museums, passenger depots, sports facilities, and public assembly halls. (This building type cannot be used to demonstrate lighting compliance and will be disabled if the *Envelope and/or Mechanical Compliance Only* checkbox is not selected.)

Exercise Center – A building or structure used for recreational activities involving physical exertion designed to promote physical fitness and well-being.

Grocery Store – A building or structure that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Hotel/Motel – A building or structure for transient occupancy; e.g., resorts, hotels, motels, barracks, or dormitories.

Library – A building or structure in which literary and artistic materials, such as books, periodicals, and audiovisuals, are kept for reading, reference, and loan.

Medical and Clinical Care – A building or structure for the purpose of providing medical treatment, confinement or care, and sleeping facilities such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, and reformatories.

Multifamily – A building or structure containing three or more dwelling units. (This building type cannot be used to demonstrate lighting compliance and will be disabled if the *Envelope and/or Mechanical Compliance Only* checkbox is not selected.)

Museum – A building used for the display and preservation of objects of artistic, scientific, or cultural interest.

Office – A building or structure for office, professional, or service type transactions such as medical offices, banks, libraries, and government office buildings.

Religious Worship– A building for worship, religious services, and associated social and educational functions.

Restaurant – A building or structure for the preparation and consumption of food or drink, including coffee shops, cafeterias, bars, and fast food and leisure restaurants.

Retail Sales, Wholesale Showroom – A building or structure for the display and sale of merchandise such as shopping malls, food markets, auto dealerships, department stores, and specialty shops.

School – A building or structure for the purpose of instruction such as schools, colleges, universities, and academies.

Storage, Industrial and Commercial – A building or structure for storage, such as aircraft hangars, garages, warehouses, storage buildings, and freight depots.

Theater—Motion Picture – An assembly room, hall, or building with tiers of rising seats or steps for the showing of motion pictures.

Theater—Performance – An assembly room, hall, or building with tiers of rising seats or steps for the viewing of dramatic performances, lectures, musical events, and similar live performances.

Other – A building or structure whose intended use is currently not known or does not match any of the above categories.

Area Categories

The following area categories are listed in the software. For area categories other than those given, select categories with similar areas and/or activities.

Auditorium – An area with fixed seats used for public meetings or gatherings not specifically for the viewing of dramatic performances.

Bank/Financial Institution – An area for conducting financial transactions, including the custody, loan, exchange, or issue of money, for the extension of credit and for facilitating the transmission of funds.

Classroom/Lecture Hall – An area of a building where classes meet.

Convention, Conference or Meeting Center – An area used for meetings, conventions, and multiple purposes, including dramatic performances, that has neither fixed seating nor fixed staging.

Corridor, Restroom, Support Area – Corridor – an area used as a passageway to access compartments or rooms. Restroom: An area providing personal facilities such as toilets and washbasins. Support: An area used as a passageway, utility room, storage space, or other use associated with the building's primary function.

Dining – An area in a restaurant or hotel/motel (other than guest rooms) where meals served to the customers are consumed.

Exercise Center – An area of a building for recreational activities involving physical exertion designed to promote physical fitness and well-being.

Exhibition Hall – An area used for exhibition that has neither fixed seating nor fixed staging.

Grocery Store – An area of a building that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Gymnasium Playing Surface – An area of a building for organized athletic games such as basketball, volleyball, racquetball, and tennis.

Hotel Function – An area such as a hotel ballroom, meeting room, exhibit hall, or conference room, together with prefunction area and other spaces ancillary to its function.

Hotel/Motel Guest Room – A room or suite of rooms in a building for transient occupancy (such as a resort, hotel, motel, barracks, or dormitory), including living and sleeping areas, private bathrooms, and kitchenettes. (Note that hotel/motel guest rooms are exempt from lighting requirements but are included in the area category list for consistency and for use in determining internal loads for envelope compliance.)

Industrial Work, < 20 ft ceiling height – An area of a building in which a manufacturing operation, craft, or art is performed having a ceiling less than 20 ft above the floor.

Industrial Work, >= 20 ft ceiling height – An area of a building in which a manufacturing operation, craft, or art is performed having a ceiling 20 or more ft above the floor.

Kitchen – An area containing facilities for cooking and food preparation.

Library – An area of a building in which literary and artistic materials, such as books, periodicals, and audiovisuals, are kept for reading, reference, and loan.

Lobby—Hotel – An area in a hotel/motel between the main entrance and the front desk, including waiting and seating areas, and other spaces encompassing the activities normal to a hotel lobby function.

Lobby—Other – An area located directly inside the main entrance of a building and includes the reception area, sitting areas, and public areas.

Mall, Arcade, or Atrium – An area of a building used as a public passageway or concourse that provides access to rows of stores or shops.

Medical and Clinical Care – An area of a building where medical treatment is provided such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, and reformatories.

Multifamily Living Unit – A private room or group of rooms for nontransient residential living that occur within a building or structure containing three or more dwelling units. (Note that multifamily living units are exempt from lighting requirements but are included in the area category list for consistency and for use in determining internal loads for envelope compliance.)

Museum – An area of a building used for the display or preservation of objects of artistic, scientific, or cultural interest.

Office – An area of a building for office, professional, or service-type transactions such as medical offices, banks, libraries, and government office buildings.

Religious Worship – An area of a building for worship or religious services.

Restaurant – An area of a building for the preparation and consumption of food or drink, including coffee shops, cafeterias, bars, and fast-food and leisure restaurants.

Retail Sales, Wholesale Showroom – An area of a building in which the primary activity is the sale of merchandise or the display of samples of merchandise.

Storage, Industrial and Commercial – An area of a building for storing items.

Theater—Motion Picture – An area of a building with tiers of rising seats or steps for the showing of motion pictures.

Theater—Performance – An area of a building with tiers of rising seats or steps for the viewing of dramatic performances, lectures, musical events, and similar live performances.

Other – An area of a building whose intended use is currently not known or does not match any of the above types.

Field Inspection Checklist

REFER TO COMPLIANCE CERTIFICATES FOR PROJECT-SPECIFIC REQUIREMENTS

Foundation and/or Slab/Under-Floor Inspection

Requirement	Verify	Reference
Slab-edge insulation installed	R-value of insulation	Envelope Certificate
Below-grade wall insulation installed	R-value of insulation	Envelope Certificate
Under-floor insulation installed	R-value of insulation	Envelope Certificate
Ducts insulated and sealed/pipes insulated	R-value of insulation	Mechanical Certificate

Frame Inspection

Requirement	Verify	Reference
All joints and penetrations are caulked, gasketed, weatherstripped, or otherwise sealed	Caulking/sealing	Envelope Certificate
Windows, doors, and skylights certified as meeting leakage req.	Label	Envelope Certificate
Window and skylight areas per plans	Area of windows/skylights	Envelope Certificate
Window and skylight U-factors acceptable	U-factors of windows/skylights	Envelope Certificate
Window SHGC factors acceptable	SHGC of windows	Envelope Certificate
Window shading installed per plans/specifications	Overhang or shade screen	Envelope Certificate

Insulation Inspection

Requirement	Verify	Reference
Wall insulation installed	Wall construction type R-value of insulation	Envelope Certificate
Ceiling/roof insulation installed	Ceiling/roof construction type R-value of insulation	Envelope Certificate
Vapor retarders installed Exception: exempted zones/states (generally Zones 2-7)	Kraft paper or equal	Envelope Certificate

Final Mechanical Inspection

Requirement	Verify	Reference
Heating and Cooling System Controls		
One setback thermostat with occupant override per zone Setback requirement exceptions: Residences & hotel/motel guest rooms areas that operate continuously Heat-pump thermostat used with heat pumps	Thermostat with battery back-up and accessible override	Mechanical Certificate
Air economizer on systems greater than 90,000 Btu/h Exceptions: exempted climate zones residences, supermarkets, hotel guest rooms high-efficiency cooling equipment tradeoff minimum EER: _____ EER: _____	Economizer installed or HVAC make and model matches plans	Mechanical Certificate
Outdoor-Air Ventilation		
Outdoor air provided to each space	Outdoor-air intake on HVAC system or required area of operable openings	Mechanical Certificate
Shutoff dampers in restaurant make-up air systems	Damper installed	Mechanical Certificate
Duct Construction		
Duct insulation installed	R-value of insulation	Mechanical Certificate
Duct sealed	Transverse joints of metal ducts and mechanical connections on other duct joints	Mechanical Certificate
Hydronic Heating Systems		
Pipe insulation	½ in. on heating coil branches	Mechanical Certificate
	1½ in. on circulation loops	Mechanical Certificate
Part-load efficiency method	Temp reset/variable flow	Mechanical Certificate

NOTE: *Final Mechanical Inspection (contd) and Final Electrical Inspection checklist on other side.*

Field Inspection Checklist (contd)

Final Mechanical Inspection (contd)		
Requirement	**Verify**	**Reference**
Other Multiple-Zone Mechanical Requirements		
See Complex Systems Certificate		
Water-Heating Systems		
Heat traps	Integral to water heater or field-fabricated	Mechanical Certificate
Pipe insulation on inlet/outlet pipes	Insulation thickness	Mechanical Certificate
Recirculating systems	Insulation thickness	Mechanical Certificate
	Automatic time-switch	Mechanical Certificate

Final Electrical Inspection		
Requirement	**Verify**	**Reference**
Controls, Switching, and Wiring		
Independent lighting controls	Switch in each room	Lighting Certificate
Exceptions:		
security lighting		
building lobby/retail store/mall		
Hotel/motel guest rooms	Master switch at entry	Lighting Certificate
At least two lighting levels in each space	Two switches, dimmer, or occupancy sensor in each space	Lighting Certificate
Exceptions:		
only one luminaire in space corridor, storage area, restroom, or lobby area		
Exterior lighting controls	Photocell or astronomical time-switch on exterior lights	Lighting Certificate
Exception:		
large covered areas requiring lighting during daylight hours		
One-lamp and three-lamp ballasted luminaires	Tandem-wired ballasts	Lighting Certificate
Exceptions:		
electronic high-frequency ballasted luminaires		
luminaires not on same switch		
Interior Lighting		
Fixtures, lamps, and ballasts	Match plans and specs	Lighting Certificate
Exterior Lighting		
Power for lighting from electrical service	Exterior-lighting circuit	Lighting Certificate
Exterior-lighting source:	Fluorescent	Lighting Certificate
	Metal halide	
	High-pressure sodium	
Exceptions:		
specialized signal, directional, and marker lighting		
lighting highlighting exterior features of historic building		
advertising signage		
safety or security lighting		
low-voltage landscape lighting		
source efficacy greater than 45 lumens per watt		

NOTE: *This form is required to be under the front seat of the inspection vehicle.*

Glossary

AAMA

Architectural Aluminum Manufacturers Association

Air Economizer Systems

Ducting arrangements and automatic control systems that allow a cooling supply fan system to supply outdoor (outside) air to reduce or eliminate the need for mechanical refrigeration during mild or cold weather.

Alteration

Any change to a building's water heating system, space conditioning system, lighting system, or envelope that is not classified as an addition.

ASHRAE/IES Standard 90.1-1989

The American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illumination Engineering Society Standard 90.1-1989.

Automatic Time-Switch Controls

Controls that automatically switch lights or equipment on and off.

Automatically Operated Control Damper

A damper which automatically opens and closes.

Ballast

A device used to operate fluorescent and HID lamps. The ballast provides the necessary starting voltage, while limiting and regulating the lamp current during operation.

Below-Grade Wall

Portions of the wall below grade.

Boiler

A pressurized system in which water is vaporized to steam by heat transferred from a source of higher temperature, usually the products of combustion from burning fuels. Steam thus generated may be used directly as a heating medium, or as the working fluid in a prime mover to convert thermal energy to mechanical work, which in turn may be converted to electrical energy.

Building Envelope

The elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces.

Ceiling

Those portions of the building envelope, including all opaque surfaces, fenestration, doors, and hatches, that are above conditioned space and are horizontal or titled at less than 60 degrees from horizontal.

Circulation Pumps

Pumps that are used to keep hot water circulating through the distribution system.

Circulating Water Heater

Hot water continuously circulates through the distribution system.

Commercial Building

Includes but is not limited to occupancies for assembly, business, education, institutions, merchants, and storage.

Compact Fluorescents

Small fluorescent lamps that are often used as an alternative to incandescent lighting. The lamp life is about 10 times longer than incandescent lamps and is 3-4 times more efficacious.

Concrete Masonry Unit Walls

Concrete masonry unit walls may be insulated by filling the empty core with perlite, vermiculite, or some other insulative material. In some cases, even with filled cores, these wall types require additional insulation.

Conditioned Floor Area

The horizontal projection of that portion of interior space which is contained within exterior walls and which is conditioned directly or indirectly by an energy-using system.

Conditioned Space

A cooled or heated space, or an indirectly conditioned space.

Connected Lighting Load

The sum of all non-exempt interior lighting power, measured in watts.

Cooled Space

An enclosed space within a building that is cooled by a cooling system whose capacity (a) exceeds 6 Btu per hour per square foot or (b) is capable of maintaining a space dry-bulb temperature of 90 degrees F or less at design cooling conditions.

Domestic Water Heating System

DHW systems may be circulating or non-circulating.

Economizer

A ducting arrangement and automatic control system that allow a cooling supply fan system to supply outdoor air to reduce or eliminate the need for mechanical refrigeration during mild or cold weather.

Efficacy

A metric used to compare light output to energy consumption. Efficacy is measured in lumens per watt. Efficacy is similar to efficiency, but is expressed in dissimilar units. For example, if a 100-watt source produces 9000 lumens, then the efficacy is 90 lumens per watt.

Electronic High-Frequency Ballasts

Electronic ballasts improve fluorescent system efficacy by converting the standard 60 Hz input frequency to a higher frequency, usually 25,000 to 40,000 Hz. Lights operating on these frequencies produce about the same amount of light, while consuming up to 30% less power than a standard magnetic ballast.

Enclosed Space

A volume substantially surrounded by solid surfaces such as walls, floors, roofs, and openable devices such as doors and operable windows. Spaces not meeting these criteria for enclosure are considered to be exterior to the building for purposes of determining envelope requirements. For example, most parking garages do not qualify as enclosed space.

Envelope Components

The building assemblies that provide a barrier between conditioned space and unconditioned space. This includes the floors, walls, and ceiling/roof assemblies of the building.

EER

The energy efficiency ratio is the ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions. When consistent units are used, this ratio becomes equal to coefficient of performance.

Fan Coil

A fan-coil terminal is essentially a small air-handling unit which serves a single space without a ducted distribution system. One or more independent terminals are typically located in each room connected to a supply of hot and/or chilled water. At each terminal, a fan in the unit draws room air (sometimes mixed with outside air) through a filter and blows it across a coil of hot water or chilled water and back into the room.

Fenestration

The terms "fenestration", "window", and "glazing" are often used interchangeably. However, fenestration refers to the design and position of windows, doors and other structural openings in a building.

Floor

A horizontal exterior partition, or a horizontal demising partition, under conditioned space which separates conditioned space from unconditioned space.

Fluorescent Lamps

A light source consisting of a tube filled with argon, along with krypton or other inert gas. When electrical current is applied, the resulting arc emits ultraviolet radiation that excites the phosphors inside the lamp wall, causing them to radiate visible light.

Fuel-Fired Furnace

A self-contained, indirect-fired furnace that supplies heated air through ducts to spaces that require it.

Glazing

The terms "fenestration", "window", and "glazing" are often used interchangeably. However, glazing is the transparent component of glass or plastic windows, doors, clerestories, or skylights.

Glazing U-Factor

Based on the interior-surface area of the entire assembly, including glazing, sash, curbing, and other framing elements. Center-of-glass U-factors cannot be used.

Gross Wall Area

Includes the opaque area of all above-grade exterior walls enclosing conditioned spaces (including above-grade portions of below-grade wall assemblies but excluding walls separating conditioned from unconditioned space); the area of the band joist and subfloor between floors; and the area of all doors and windows.

Gross Window Area

Includes the rough-opening area of the window, not just the transparent-glass area.

Heat Pump

One or more factory-made assemblies which include an indoor conditioning coil, compressor(s) and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions.

Heat Traps

Devices or piping arrangements that effectively restrict the natural tendency of hot water to rise in vertical pipes during standby periods. Examples are the U-shaped arrangement of elbows or a 360-degree loop of tubing.

Heated Space

An enclosed space within a building that is heated by a heating system whose output capacity (a) exceeds 10 Btu per hour per square foot and (b) is capable of maintaining a space dry-bulb temperature of 50 degrees F or more at design heating conditions.

HID

High intensity discharge. Generic term describing mercury vapor, metal halide, high pressure sodium, and (informally) low pressure sodium light sources and luminaires.

High-Pressure Sodium Lamps

High-intensity discharge (HID) lamps whose light is produced by radiation from sodium vapor (and mercury).

High-Rise Residential Buildings

Hotels, motels, apartments, condominiums, dormitories, and other residential-type facilities that provide complete housekeeping or transient living quarters and are over three stories in height above grade. Hotels, motels, and other buildings with itinerant occupancies are covered by the "commercial" code regardless of height.

HVAC

Heating, ventilating, and air-conditioning

HVAC System

The equipment, distribution network, and terminals that provide either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

ICAA

Insulation Contractors Association of America

ICC

International Code Council

IMC

International Mechanical Code

Indirectly Conditioned Space

An enclosed space within a building that is not a heated or cooled space, whose area-weighted heat transfer coefficient to heated or cooled spaces exceeds that to the outdoors or to unconditioned spaces; or through which air from heated or cooled spaces is transferred at a rate exceeding three air changes per hour. (Also see Heated Space, Cooled Space, and Unconditioned Space.)

Insulation R-Values

R-values are used to rate insulation and are a measurement of the insulation's resistance to heat flow. The higher the R-value, the better the insulation.

Integrated-Control Economizers

Allows the cooling load of a building or space to be partially met by supplying outside air while the rest of the load is met by the refrigeration equipment within an HVAC system. Field- and factory-installed economizers supplied by major equipment manufacturers include integrated controls.

Interior-Lighting Controls

Offer the ability for systems to be turned on and off either manually or automatically and include switches, time clocks, occupancy sensors and other devices that regulate a lighting system.

Interior Lighting Power Limits

The maximum total wattage for a building or space that can be installed to meet the provisions of the energy code.

Longitudinal Seam

A duct seam that is parallel to the direction of air flow.

Luminaire

A complete lighting unit consisting of a lamp or lamps, along with the parts designed to distribute the light, hold the lamps, and connect the lamps to a power source. Also called a fixture.

Mechanical System

The system and equipment used to provide heating, ventilating, and air conditioning functions as well as additional functions not related to space conditioning, such as, but not limited to, freeze protection in fire protection systems and water heating.

Metal Building Walls and Roofs

Special attention to the design and construction of metal buildings is required to ensure these buildings meet the COM*check-EZ* requirements. Two key elements exist in metal buildings that are not found in other building classes – thermally broken connections between the purlin and metal roof sheet and compression of insulation behind wall girths and roof purlins.

COM*check-EZ* includes requirements for metal building walls and roofs. These requirements are specified in the "Walls Framed – Metal Framing" category and in the "Roofs Metal Purlin" category in the Prescriptive Packages. There are two classes of metal building roofs. One class uses traditional techniques that drape the insulation over the purlin and fasten the metal roof sheets through the insulation directly to the purlin. The second class requires that a thermal block be placed between the metal roof sheet and purlin.

A thermal block consists of foam blocks or other materials/techniques that prevent heat from migrating from the purlin directly to the metal roof sheet. Compressed fiberglass batt insulation does not qualify as a thermal block.

Metal Halide Lamps

A type of high intensity discharge (HID) lamp in which most of the light is produced by radiation of metal halide and mercury vapors in the arc tube. Available in clear and phosphor-coated lamps.

NWWDA

National Wood Window and Door Association

Occupancy Type

The type of activity occurring within a building.

Occupant-Sensing Device

A device that detects the presence or absence of people within an area and causes any combination of lighting, equipment, or appliances to be adjusted accordingly.

Packaged Boiler

A self-contained unit that generally requires little maintenance.

Packaged Terminal Air Conditioner

A factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies, or sections (intended for mounting through the wall to serve a single room or zone). It includes heating capability by hot water, steam, or electricity.

Packaged Terminal Heat Pump

A packaged terminal air conditioner capable of using the refrigeration system in a reverse cycle or heat pump mode to provide heat.

Permanently Wired Luminaires

Light fixtures physically attached to a surface (e.g. ceiling or wall) using a permanent mounting system and wired directly to a power source. Examples include fluorescent fixtures located in a ceiling grid and wall sconces.

Perm Rating

The amount of water vapor that passes through an area in a certain period of time.

Photocell

A light sensing device used to control luminaires and dimmers in response to detected light levels.

Plenum

An enclosure that is part of the air-handling system and is distinguished by having a very low air velocity. A plenum often is formed in part or in total by portions of the building.

Projection Factor

The exterior horizontal shading projection depth divided by the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the external shading projection in units consistent with the projection depth.

Residential Buildings

Detached one and two family dwellings. A building containing multiple (i.e., three or more) dwelling units where the occupants are primarily permanent in nature, such as townhouses, row houses, apartment houses, convents, monasteries, rectories, fraternities and sororities, dormitories, and rooming houses, all of which are three stories or less in height above grade.

Roof

Those portions of the building envelope, including all opaque surfaces, fenestration, doors, and hatches, that are above conditioned space and are horizontal or tilted at less than 60 degrees from horizontal.

R-Value

Thermal resistance to heat flow. A larger number means less heat flow.

Service Water Heating

The supply of hot water for purposes other than comfort heating and process requirements.

Single-zone, Unitary HVAC Systems

Unitary HVAC systems that serve a single zone. Single zone systems can provide either heating or cooling, but provide supply air at the same volume and temperature to the entire zone which they serve.

Skylight

Glazing that is horizontal or tilted less than 60 degrees from horizontal.

Shading Coefficient

The ratio of solar heat gain through fenestration, with or without integral shading devices, to that occurring through unshaded 1/8-in.-thick double-strength glass.

Solar Heat Gain Coefficient

The glazing's effectiveness in rejecting solar heat gain. SHGC is part of a system for rating window performance used by the National Fenestration Rating Council (NFRC). SHGC is gradually replacing shading coefficient (SC) in product literature and design standards.

Split System

Split-system HVAC equipment has the indoor and outdoor coils within separate cabinets. For a cooling only system, the outdoor cabinet would contain the condenser coil and the indoor cabinet would contain the evaporator coil.

Structural Masonry Wall

A wall construction category used with masonry, precast and poured-in-place concrete, and concrete masonry units. You can select from among six specific types of masonry wall constructions by clicking the *Ext. Wall* button and selecting *Structural Masonry Wall* or by clicking the *Basement* button.

Switched Receptacles

The ability to turn power on and off to an electrical outlet by using a control switch.

Tandem Wiring

A wiring option in which a ballast is shared by two or more luminaires. This reduces labor, materials, and energy costs.

Temperature Reset Controls

Controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature.

Thermostat

An automatic control device responsive to temperature.

Thermostat Set Back

Usually done at night to reduce the amount of conditioning provided at night by allowing the interior temperature to drift naturally to a marginal temperature during the night and then to recondition it to normal conditions in the morning.

Transverse Seam

All duct seams other than the longitudinal seam (which runs parallel to the direction of air flow).

U-Factor

The amount of heat in Btu that flows each hour through one square foot, when there is a 1 degree F temperature difference across the surface. The smaller the number, the less heat flow.

UL 181A

A test procedure for tapes and mastics used to seal ductwork.

UL 181B

A test procedure for tapes and mastics used to seal ductwork.

Unconditioned Space

An enclosed space within a building that is not a conditioned space.

Unitary-Packaged

Each package is a standalone system which provides all of the heating and cooling requirements for the area of the building which it serves.

Vapor Retarder

A component that retards water vapor diffusion, but does not totally prevent its transmission. Vapor retarder material is usually a thin sheet or coating. However, a construction of several materials, some perhaps of substantial thickness, could also constitute a vapor retarder system.

Variable-Air Volume (VAV) System

HVAC system that controls the dry-bulb temperature within a space by varying the volume of heated or cooled supply air to the space.

Variable-Frequency Drive

Changes the speed of the motor by changing the voltage and frequency of the electricity supplied to the motor based upon system requirements.

Ventilated Naturally

The process of supplying or removing air by natural means to or from any space.

Ventilated Mechanically

The process of supplying or removing air by mechanical means to or from any space. Such air may or may not have been conditioned.

Visible Light Transmittance

The fraction of solar radiation in the visible light spectrum that passes through the fenestration.

Wall

Opaque portion of the building envelope.

Water Heating

The process or system used to heat service water.

Water Temperature Reset

Temperature shall be reset by at least 25% of the design supply-to-return water temperature difference.

Window

The terms "fenestration", "window", and "glazing" are often used interchangeably. However, window actually describes a system of several components. Window is the term given to an entire assembly comprised of the sash, glazing, and frame.

Window-Wall Ratio

The gross window area divided by the gross wall area.

Zone

A space or group of spaces within a building with any combination of heating, cooling, or lighting requirements sufficiently similar so that desired conditions can be maintained throughout by a single controlling device.